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THE

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JOURNAL OF PHYSICAL SCIENCE.

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IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

EDITED BY

WILLIAM CROOKES, F.R.S., &c.

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THE CHEMICAL NEWS.

VOLUME LV.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1415.—JANUARY 7, 1887.

ON COHESION AND SUBMERSION FIGURES.

By CHARLES TOMLINSON, F.R.S., F.C.S.

In the CHEMICAL NEWS (vol. liv., p. 58, July, 1886) is an abstract of a lecture delivered by Mr. William Ackroyd, F.I.C., before the Halifax Scientific Society, in July last, in which it is stated that when a liquid drop descends below the surface of water, and assumes a ring shape which gradually spreads out, and breaks up into lesser rings, such figures are not "submergence cohesion figures," as they have been called, but vortex rings. In the abstract of this notice, given in the *Journal of the Chemical Society* for December last, the author is said to justify the above notion by comparing the conditions of formation of aërial and of liquid vortex rings, and showing their resemblance.

In 1861 I introduced the subject of the cohesion figures of liquids to the British Association at its meeting in Manchester, and exhibited a large number of figures; and at the meeting at Bath in 1864 other figures, modified by the various surfaces on which they were exhibited, were shown, together with a new set of figures under the name of "Submersion Figures." In addition to the brief notices in the *British Association Reports*, full descriptions, with illustrative engravings, were inserted in the *Philosophical Magazine* and elsewhere. The subject has since been taken up by Mr. Worthington, Messrs. J. J. Thomson and Newall, and others.

I may remark that I did not name this second set of figures "Submergence Cohesion Figures," but simply "Submersion Figures," such as, in fact, they really are, and involving no theory as to their formation or structure. I was led to the study of them while preparing a lecture at King's College, when, having occasion for an aqueous solution of cochineal, a number of the insects was crushed in a mortar together with a small quantity of water, and so poured upon a filter standing over a vessel of water. I noticed that as the drops descended beautiful curved lines were formed, and I thus received the suggestion for a new and interesting inquiry. In my first experiments the cochineal figures were greatly improved by mixing a little alum with the water into which the drops were received. Various other liquids besides water contained in cylindrical glasses were used as recipients, and drops of various liquids were also employed. I was not aware at this time that liquid vortex rings had been described; but on showing my results to Professor Miller he informed me that Professor Rogers had a paper on liquid rolling rings in the *American Journal of Science* for September, 1858, and he lent me the copy that he had received from the author.

In my first paper on "Submersion Figures," in the *Phil. Mag.* for June, 1864, an abstract is given of Professor Rogers's paper, and in the plate which accompanies my paper a diagram is given showing a drop on a horizontal line which, descending into a liquid column, forms a liquid rolling ring, the structure of which is given; or, ascending like a bubble of phosphuretted hydrogen, forms an aërial rolling ring, the structure of which is also given. The plate further shows the figures of drops of a dense aqueous solution of cochineal in a column of alum water, and also in one of oxalate of ammonia, oil of lavender in spirit, croton oil in benzole and in paraffin oil, fusel oil in paraffin oil, benzole in ether, oil of bitter almonds in benzole, common salt in water, &c. In subsequent papers (November, 1864, &c.) other figures are represented, such as those formed by drops of sesame, and colza oils in cocoa-nut oil, oil of cloves in castor oil, castor or croton oil in melted lard, croton and cinnamon oils and creosote in a column of olive oil.

At the meeting of the British Association at Edinburgh, in 1871, Mr. H. Deacon, not knowing my results, brought before the Chemical Section some figures that he had obtained by allowing drops of heavy liquids or solutions to fall into a column of water. Before the reading of his paper he was introduced to me, and he showed me the drawings of some of his figures, which I told him were identical with some of mine, and referred him to my papers in the *Phil. Mag.*, which he consulted in the library of the Royal Society of Edinburgh.

At that time some distinguished physicists of Edinburgh were very much interested in the subject of vortex rings, and Professor Clerk Maxwell informed me that he had produced some of my figures by allowing water to fall from a height through the air, from an upper window for example. After the reading of Mr. Deacon's paper, and the exhibition of his figures (which soon after appeared in the CHEMICAL NEWS) there was some discussion as to the best mode of exhibiting vortex rings, aërial and liquid, and I gave some particulars respecting their exhibition at the lecture table.

Professor Daniell, of King's College, was accustomed to exhibit smoke rings by means of a tinned iron cone covered at the base with a parchment head, and furnished at the truncated end with a short tube. On filling this with smoke, and striking the parchment, smoke rings were shot out into the air. About 1842 Dr. Boswell Reid was engaged by the Committee of Council on Education to lecture to some of the charity schools of the metropolis, and the children were accustomed to assemble in Exeter Hall, each school occupying a set of benches by itself, so that the coloured costumes of the

children had an odd effect—the greens in one place, the drabs in another, and so on; but the oddest part of the affair was in the delivering of separate courses of lectures to separate groups. The lecturer might be addressing the greens, for example, giving them half-an-hour or so, and then turning to the greys begin on a new subject to them in continuation of some previous lecture. In this way he got through several lectures in one evening. His apparatus was adapted to the size of the lecture-room and the distance of his pupils from the platform. Thus his apparatus for producing smoke rings was of the size of a large drum, and on striking the parchment head with his fist the lecturer projected a fine smoke ring through the air of the hall. Some years later, on the Emperor's fête day in Paris, splendid smoke rings were produced for the amusement of the populace from the greased mouths of cannon fired with blank cartridge. In the *Annales de Chimie et de Physique*, for 1864, my submersion figures were noticed, and also a box contrived by M. Coulier, from which rings of chloride of ammonium smoke were projected.

But, to return to the liquid vortex rings, Mr. Deacon inserted in this journal a couple of papers, in which he was very angry with me. He quoted largely from Prof. Rogers's paper; but as I had already done full justice to the American physicist, it was not necessary for me to reply.

In 1868, while studying the action of nuclei in liberating vapour from boiling liquids, a curious observation was made. Some oil of turpentine was being heated in a test-tube over the flame of a spirit-lamp. About half way down the tube was a speck of carbon which had apparently become attached while the glass in the process of manufacture was still soft. As soon as the turpentine had reached the boiling point, a series of rapid intermittent vortex rings escaped from the carbon point with such rapidity as to form a low musical note. Each jet consisted of about twelve or fifteen rings expanding upwards from a point. This led me to seek for some numerical values as to the action of porous bodies in liberating vapour from boiling liquids. I take one example from my paper inserted in the *Proceedings of the Royal Society* for January, 1869. Water boiled in a clean flask lost in twenty minutes 995 grains; and again, during the same time, and with the same amount of heat, but with a nucleus of coke in the water, the loss was 1130 grains; the ratio of the products being as 100 : 113·6.

Charcoals made from boxwood and cocoa-nut shell are still more active as nuclei in liberating vapour from a boiling liquid under distillation; while at the same time they prevent the bumping of the vessel.

Highgate, N., January 1st, 1887.

CHROMIC ACID COMBUSTION OF GLYCERIN.

By C. F. CROSS and E. J. BEVAN.

We have recently noticed the description of a method for the estimation of glycerin (in wines), based upon combustion with chromic acid in presence of concentrated sulphuric acid (L. Legler, *Rep. An. Ch.*, 1886, 6, 631; *Chem. Ztg.*, 1886, 262). The author adopts the gravimetric method of determining the products of combustion. It occurred to us to try this particular combustion according to the volumetric method described by us some time since in the CHEMICAL NEWS, vol. lii., p. 207. The carbon percentage estimated by this method in pure glycerin was 38·7, the theoretical number being 39·1; the method therefore gives satisfactory results in this case as we have found in many others.

For the benefit of those who are in possession of the instrument we would mention that Lunge's nitrometer is well adapted to the purpose. We intend at an early opportunity to give a detailed account of the method as applied to a variety of carbon compounds.

4, New Court, Lincoln's Inn.

ACIDIMETRIC PROCESS FOR ESTIMATING "CHROMATE" IN PRESENCE OF "BICHROMATE."

By NORMAN McCULLOCH.

Bichromate of soda, as a technical substitute for bichromate of potash, is of rising importance on account of its greater cheapness, strength of chromic acid, and solubility in water; and with improved means of storage to protect it from atmospheric moisture and consequent deliquescence, bids fair to entirely replace it.

In the CHEMICAL NEWS, vol. liv., p. 194, we are favoured by Mr. Arthur Stanley with a few "Properties and Constants" of bichromate of soda.

The usual impurities of the commercial salt are, conveniently speaking, water, chloride of sodium, sulphate of soda, bichromate of potash, and chromate of soda. The analysis of the last-named constituent alone calls for any special comment, and the subject of this communication is a convenient process for its estimation.

A method for directly determining chromate in presence of bichromate has not so far, to my knowledge, been suggested, and consequently the most approved procedure for analysing such mixtures consists in the direct estimation of the bichromate by titration with standard caustic alkali in presence of phenolphthalein, until by its complete conversion into normal chromate, with slight excess of alkali, the reddish yellow of the solution changes to a yellowish red; and after subtracting the chromic acid equivalent of the bichromate so found from the total chromic acid as estimated with ferrous salt we have as a remainder the chromic acid existing in the sample as chromate.

The results are fairly satisfactory, but the method has a practical drawback in the fact that the exact conversion of the bichromate into the normal salt is not defined by the phenol phthalein with sufficient sharpness, and the operator in standardising his caustic alkali with pure potassium bichromate must hit a degree of neutral tint to be rigidly adhered to in titrating unknown quantities.

In devising a process superior to the above I have taken advantage of the fact that neither bichromate nor chromate yield to a mixture of peroxide of hydrogen and ether the well known blue colouration of chromium heptoxide peculiar under these circumstances to free chromic acid, and in the case of chromate the phenomenon develops only with the addition of such a quantity of acid as is slightly in excess of that necessary to completely convert the chromate into bichromate.

To apply these facts to practical work, 5 or 10 grms. of the sample are placed in a test-tube 4 centimetres in diameter and ¼ metre or so in length, and dissolved in a small quantity of water. A few c.c. of peroxide of hydrogen (10 vols.) are added, and the whole covered with a layer of sulphuric ether 3 centimetres in depth. The mouth of the test-tube is now stopped with a paraffined cork pierced in the centre with a short glass tube for admitting the standard sulphuric acid, which is run in from a burette in small quantities at a time, with agitation after each addition, until the layer of ether is tinged faintly blue as best seen against a white background. By calculating the equivalent of acid consumed to two equivalents of chromate of soda or potash, as the case may be, we obtain the chromate in the portion of the sample taken.

Judging from the very dark colour that peroxide of

Value of Test-Acid, calc. from Expts. 1 *and* 2. C.c.=0·0113 grm. Na_2CO_3=0·4148 grm. K_2CrO_4.
„ „ „ 4 *and* 5. C.c.=0·011236 „ „ 0·4124 „ „

No. of Expt.	Indicator.	Material and the quantity used.	C.c. of Test-Acid added.	Quantity found, calc. from 1 and 2.	Quantity found, calc. from 4 and 5.
1.	Litmus	1·6197 grms. Na_2CO_3	143·34	—	—
2.	Litmus	1·6197 grms. Na_2CO_3	143·34	—	—
3.	H_2O_2 and ether	1·6197 grms. Na_2CO_3+0·32 grm. $K_2Cr_2O_7$	143·99	1·6268	—
4.	Ditto	1·6197 grms. Na_2CO_3+1·62 grms. $K_2Cr_2O_7$	144·15	1·6288	—
5.	Ditto	0·6479 grm. Na_2CO_3+3·2 grms. $K_2Cr_2O_7$	57·66	0·6511	—
6.	Ditto	3·2394 grms. K_2CrO_4	78·20	3·2433	3·2245
7.	Ditto	3·2394 grms. K_2CrO_4	78·39	3·2518	3·2330
8.	Ditto	3·2394 grms. K_2CrO_4	78·33	3·2485	3·2297
9.	Ditto	0·6479 grm. K_2CrO_4+3·24 grms. $K_2Cr_2O_7$	15·73	0·6524	0·6491
10.	Ditto	0·01296 grm. K_2CrO_4+3·24 grms. $K_2Cr_2O_7$	0·32	0·1295	0·1295
11.	Ditto	0·00648 grm. K_2CrO_4+3·24 grms. $K_2Cr_2O_7$	0·19	0·0077	0·0077

hydrogen imparts to salts of bichromic acid a perchromate seems to be formed and is insoluble in ether. The existence of that colour is a convenient indication in this process of the peroxide of hydrogen which has escaped decomposition during titration, and unless that quantity is such as to render the colour of the liquid practically opaque about the completion of the operation, a further addition of that reagent will be necessary.

The peroxide of hydrogen I employed contained traces of acid, but too minute to be of consequence.

In manipulating the above process there is a tendency to overdo the addition of the acid, but the depth of colour imparted to the ether will roughly measure such an excess and be a guide to a more cautious titration in a second experiment. We may, alternatively, discharge the blue colour with standard chromate of potash solution.

The experimental results I append in examination of the process are carefully calculated from the grain to the grm. system of weights and measures; I think the table will explain itself.

I have simply now to say that the acidimetric process for determining chromate is quick and easy of execution.

Laboratory of Clyde Iron Works (by Tolcross), Glasgow, December 20, 1886.

THE RECIPROCAL RELATIONS BETWEEN THE PRINCIPAL FORCES OF NATURE.*

By M. EMILE SCHWŒRER.

In the monthly review, *Natur und Leben*, M. H. J. Klein, the well-known astronomer of Cologne, gave a remarkable analysis of two recent works, the one by M. Hein and the other by M. Clausius, concerning the reciprocal relations of the principal forces of nature. This analysis seems to me to be quite worthy of reproduction; I have therefore the honour of laying it before the Academie des Sciences.

Starting with the statement made by M. Clausius, in his inaugural address as Rector of the University of Berne, and then examining attentively the more recent work published by M. Hirn under the title of "The Idea of Force," M. Klein shows very clearly that these two works constitute two characteristic steps in modern scientific philosophy.

M. Clausius points out, in a very complete manner, the difference which exists between the ideas formerly held by physicists concerning the forces of nature, such as heat, light, electricity, &c., and those which, through the recent progress of science, have since been substituted; he dwells on the relations which exist between these different forces, but at the same time he lays stress on the strangely erroneous character of certain expressions which have been introduced; he points out how incorrect are the terms *the transformation of heat into electricity*, and *electricity into heat*, &c. While examining these facts he gradually arrives at the formulation of the following important proposition, viz.:—That we can in all probability explain the propagation of radiant heat and light by the action of electric forces, and that we ought therefore to substitute electricity itself for the ancient *ether*, which is supposed to fill all space and all bodies.

According to M. Clausius the physical sciences have arrived at this fundamental point, that beyond ponderable matter there exists but one particular substance, and that all phenomena will be explained by the various movements of this substance.

Passing then to the examination of the "Idea of Force" M. Klein makes it evident that M. Hirn has made an immense step in advance by considering force, taken generally, as a class of elements specifically distinct from so-called ponderable matter, by establishing the fact that electricity, heat, &c., the old imponderables of physics, are, in a word, not particular species of matter, or vehicles of force, but actually *forces* forming a common class with gravitation, for instance.

We cannot give M. Klein too much praise for the courage he has shown as a public man in pronouncing such a decided opinion in a great struggle, whose final result will be to definitely discredit the ancient doctrine of Epicurus, admitted under other names as truth exclusive to our epoch, and for having brought into the domain of experimental physics the great and important questions which had been relegated by public opinion to the shades of metaphysics.

* Read before the Academie des Sciences, Oct. 11, 1886.

ON THE DENSITY OF WEAK AQUEOUS SOLUTIONS OF CERTAIN SALTS.*

By J. G. McGREGOR, D.Sc.

The following experiments were made with two objects: (1) to determine whether or not there are solutions of the salts used, given volumes of which are less than the volumes at the same temperature of the water which they contain; and (2) to find how the density of very weak solutions varies with their strength.

Prof. Ewing† and I had found, by two experimental methods, that sufficiently weak solutions of sulphate of copper contain amounts of water whose volumes if free would be greater than those of the solutions themselves; and that anhydrous copper sulphate, added in small quantities to water, produces solutions of smaller bulk than the original water. We had also‡ found that certain

* *Trans. Roy. Soc. Canada.*

† *Trans. Roy. Soc. Edin.*, vol. xxvii. (1873), p. 51; *Reports Brit. Assoc.* (1877); *Trans. Roy. Soc. Canada*, vol. ii. (1884), sec. iii., p. 69.

‡ *Trans. Roy. Soc. Edin.*, vol. xxvii. (1873), p. 51.

somewhat rough density-measurements had indicated the same peculiarity in the case of zinc sulphate. It seemed desirable, therefore, to subject this salt to careful experiments, and to extend the investigation to other hydrated salts.

The data which we possess as to the variation of the density of solutions with their strength, do not generally extend to weaker solutions than those which contain 2 or 3 per cent of salt, and are insufficient to settle the question. I have therefore made observations in the case of zinc sulphate and other salts, which both determine the question of the possession of the peculiarity referred to above, and supply a portion of what has hitherto been lacking in our knowledge of the phenomena of their solution.

My apparatus consisted of four dilatometers, which were large glass bottles (commonly called Winchester quarts), with glass tubes fitted in their necks. The bottles had capacities of about 2600 c.c. The glass tubes were about 25 c.m. in length and 0·4 sq. c.m. in section, and were chosen so as to be as uniform in bore as possible. They were fitted to the bottles by means of india-rubber stoppers, and fitted so tightly that there could be no danger of any relative displacement of tube and bottle. The rubber stoppers were held fast to the bottle by wires. Their inner ends were hollowed conically, and the glass tubes started from the summits of the conical hollows, so that air-bubbles could easily be made to pass up the tubes. At their upper ends the tubes widened into funnels. Fine scratches on the tubes served as zero marks. The bottles stood in a large zinc bath up to their necks in water. The dilatometers were calibrated by being filled with distilled water of known temperature, from measuring vessels whose volumes were known. The one used in calibrating the tubes was so divided that changes in the volume of the water it contained could be read to 0·05 c.c. The water, with which the bottles were thus filled, had been freed from air under the receiver of an air-pump.

To test the tightness of the stoppers, the dilatometers were filled until the upper surfaces of the water were near the tops of the tubes. The stoppers were thus subjected to as great pressures as they would be during the experiments. After the bottles had taken the temperature of the bath, I observed the variation of the height of the water in the tubes from time to time, until I had satisfied myself that there was no leak,—a return to a formerly observed height in one bottle being accompanied in all cases by a similar return in the others.

I next satisfied myself that differences of temperature between the bottles, greater than any which could arise during the experiments through the dissolving of salt in some bottles and not in others, would vanish in less than the time that was to intervene between successive measurements.

As the dilatometers could not be kept at constant temperature, and as any change of volume of their contents must therefore be partially due to change of temperature, it was necessary to know the relative apparent thermal expansion of their contents. For this purpose, both at the outset when all the bottles contained water, and at intervals during the series of experiments when some of them contained solutions, the temperature of the bath was varied, and the heights of the water or solutions in the different tubes were observed when the bottles had assumed the temperature of the bath. These results were tabulated for purposes of correction.

The solutions, whose volumes were measured, were formed by the addition of known masses of anhydrous salt to the water in the bottles. The salt was simply dropped little by little down the tubes of the dilatometers. In some cases no difficulty was experienced; in others the salt was found to cake occasionally at the surface of the liquid. In these cases various expedients were adopted to hasten the solution; but the greatest care was taken to prevent the loss, either of any of the salt which had been weighed out for solution, or of any of the liquid in the bottles. When the desired amount of salt had been added to a bottle, the upper end of the tube was closed with a small cork to prevent evaporation, and the bottle was put in the bath. After an interval of about twenty-two hours the bottle was taken out, and, if the salt was found to be dissolved, was first well corked and then rolled, until its contents had been thoroughly mixed. It was then replaced in the bath and left for another hour, when the height of the free surface of the liquid was observed. Not possessing a cathetometer, I required, for measuring differences of level, to trust to a steel scale placed in contact with the tube. Care was of course taken to avoid parallactic errors as much as possible.

To one of the four bottles no salt was added; and it was kept carefully corked up, so that the quantity of water it contained might be constant. The variation of the height of the water in the tube of this bottle was due, of course, to change of temperature alone. This variation being observed, and the relative apparent thermal expansions of the liquids in the four bottles being known from the subsidiary experiments referred to above, the variations, due to changes of temperature, of the heights of the solutions in the tubes of their respective bottles could be determined and eliminated. The variations of temperature were in all cases slight, the bath being large and its daily thermal history being very constant.

The salts which I used, zinc sulphate ($ZnSO_4$) magnesium sulphate ($MgSO_4$), and calcium chloride ($CaCl_2$) were bought as pure, re-purified by crystallisation, and dehydrated by careful heating to the necessary temperature.

In all cases, after the solutions had stood a while, a slight fluffy appearance presented itself in the bottles. The mass of the precipitated solid was, however, very small,—so small that it was hardly possible to weigh it. Hence I considered that its effect on the result might be neglected. It was probably due to the presence of some impurity in the water, perhaps of ammmonia.

The following are the results of the experiments:—

Zinc Sulphate—$ZnSO_4$.

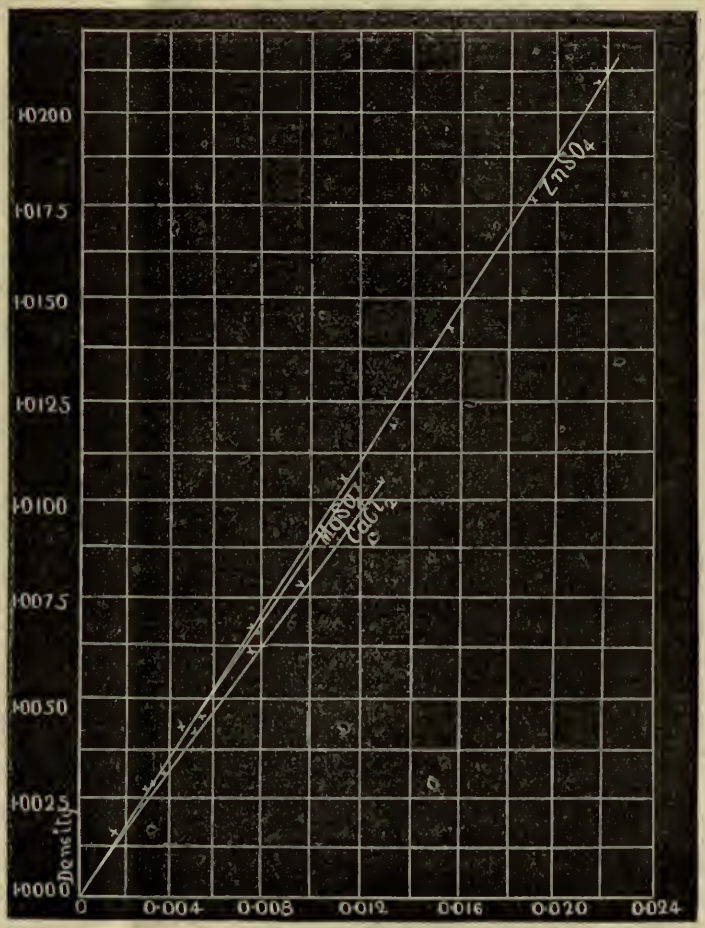
Volume of bottle to zero mark at 19·5° C. = 2687 c.c.
Mass of water in bottle = 2683·1 grms.
Mean section of tube = 0·40 sq. c.m.

Mass of salt added. (Grms.)	Mass of salt per unit mass of water.	Mass of salt per unit mass of solution.	Rise of solution in tube, corrected for change of temperature. (c.m.)	Increment of volume per unit of initial volume.	Density of solution. (Grm. per c.c.)
5	0·00186	0·00186	0·46	0·0000685	1·00179
5	0·00373	0·00371	1·10	0·0001638	1·00356
5	0·00559	0·00556	1·77	0·0002635	1·00530
5	0·00745	0·00740	2·24	0·0003335	1·00711
10	0·01118	0·01106	3·48	0·0005181	1·01065
10	0·01491	0·01469	5·36	0·0007979	1·01410
10	0·01863	0·01829	7·23	0·0010763	1·01753
10	0·02236	0·02187	8·12	0·0012089	1·02112
10	0·02609	0·02542	9·97	0·0014842	1·02446
10	0·02981	0·02895	11·98	0·0017834	1·02798

In the above Table the first and fourth columns contain the results of observation; the others are calculated from these. The third column shows the solutions examined to have been of strengths varying from 0·186 to 2·895 per cent of salt in solution. The fourth and fifth columns shew that even the weakest solution formed has a volume greater than that of the water which it contains.

The former rough measurements, alluded to above, which seemed to show that weak solutions of this salt had volumes less than the volumes of the water they contained, were made with solutions, the weakest of which was of about 2·5 per cent strength. It appears, therefore, that zinc sulphate solutions do not exhibit this peculiarity.

The relation between the mass of salt per unit mass of solution and the density of weak solutions of this salt is shown graphically in Plate I. The points determined by



Mass of Anhydrous Salt in Unit Mass of Solution.

taking the former as abscissæ, the excess of the latter over unity as ordinates, are found to lie very nearly on a straight line passing through the origin. For these solutions, therefore, the increase of density, due to the addition of anhydrous salt to water, is approximately simply proportional to the percentage of salt in the solution thus formed.

The agreement of the density of the strongest solution of the above table with that of the same solution as determined by interpolation in the results of Gerlach* and of Schiff, is shown by the following numbers:—

According to Schiff, density	=	1·0289 at 20°·5 C.
,, Gerlach ,,	=	1·0298 at 15°· C.
,, above table ,,	=	1·0280 at 19°·5 C.

This is the only one of the above solutions with which Schiff's and Gerlach's results are comparable. (See Table at top of next page).

As in the former table, the first and fourth columns contain the experimental results. The strengths of the solutions examined varied from 0·191 to 1·132 per cent of salt in solution. The fourth and fifth columns show that the volumes of all these solutions are greater than those of the water they contain. This salt therefore does not exhibit the same peculiarity as copper sulphate.

The relation between the concentration and the density of these solutions is shown graphically in Plate I. The points, whose co-ordinates are the mass of salt per unit mass of solution and the excess of the density over unity respectively, lie very nearly on a straight line passing through the origin. For weak solutions of this salt, therefore, the increase of density is simply proportional to the percentage of salt in solution.

So far as I know, there are no existing observations with which any of the above may be compared. Those of Hassenfratz, Schiff, and Gerlach were all made with solutions of greater strength. (See Table on next page).

The direct experimental results are contained in the

* Gerlach, *Fresenius's Zeitschrift*, viii. (1869), 245.

Magnesium Sulphate—$MgSO_4$.

Volume of bottle to zero mark at 9·5° C. = 2619·6 c.c.
Mass of water in bottle = 2618·9 grms.
Mean section of tube = 0·40 sq. c.m.

Mass of salt added. (Grms.)	Mass of salt per unit mass of water.	Mass of salt per unit mass of solution.	Rise of solution in tube, (corrected for variation of temp.) (C.m.)	Increment of volume per unit of initial volume.	Density of solution. (Grm. per c.c.)
5	0·00191	0·00191	0·93	0·0001420	1·00170
5	0·00382	0·00380	2·25	0·0003436	1·00346
5	0·00573	0·00569	3·06	0·0004672	1·00526
5	0·00763	0·00758	3·80	0·0005802	1·00705
10	0·01145	0·01132	5·48	0·0008368	1·01060

Calcium Chloride—$CaCl_2$.

Volume of bottle to zero mark at 9·5° = 2616·5 c.c.
Mass of water in bottle = 2615·8 grms.
Mean section of tube = 0·41 sq. c.m.

Mass of salt added. (Grms.)	Mass of salt per unit mass of water.	Mass of salt per unit mass of solution.	Rise of solution in tube, (corrected for variation of temp.) (C.m.)	Increment of volume per unit of initial volume.	Density of solution. (Grm. per c.c)
5	0·00191	0·00191	1·57	0·0002478	1·00168
5	0·00382	0·00381	4·07	0·0006426	1·00317
5	0·00573	0·00570	6·67	0·0010528	1·00465
5	0·00765	0·00759	9·47	0·0014948	1·00615
5	0·00956	0·00947	12·19	0·0019241	1·00765
10	0·01338	0·01320	18·22	0·0028759	1·01050

first and fourth columns. The strengths of the solutions examined varied from 0·191 to 1·32 per cent of salt in solution. The fourth and fifth columns show that, as in the case of the other two salts examined, all the solutions were more bulky than the constituent water.

The relation between the concentration and the density of these solutions is shown graphically in Plate I., the mass of salt per unit mass of water being plotted against density. The result is a curve bending towards the axis of concentrations. In the case of this salt, therefore, the rate of change of density with concentration diminishes with the concentration.

I am not aware of the existence of any observations with which the above may be compared. Those of Schiff, Kremers, and Gerlach were all made with solutions of greater strength.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 329.)

The Secretary, in the absence of Dr. Dabney, read the following:—

Raleigh, N. C., August 24, 1886.

Gentlemen,—Your Committee on Nitrogen esteemed it most important to settle upon a general method for determining nitrogen in the course of fertiliser work. To this end they thought that the best plan was to send out a well-defined method along with the samples, which was to be used by all of the analysts, and compared with such other methods as they choose to try.

It was desirable that the method thus put on trial should be applicable to all the ordinary sources of nitrogen, simple, easy, and rapid of execution in the most ordinary laboratory, and that it should promise to give results agreeing fairly with those obtained by the so-called absolute method, when carried out with the best apparatus and manipulation.

The committee selected the Ruffle method as promising the most by this standard, and sent out a description of it to your members.

The results on the first samples were so late coming in that we were unable to send out other samples and another method, as we expected to do.

We have the honour of submitting herewith the results obtained by the Ruffle method, as described, and by some other methods, upon four samples of different kinds.

These results are encouraging. Omitting two or three very out of the way results, which are clearly due to accidents, the figures agree very well. The Committee's Ruffle method gives results on the different materials which agree remarkably well.

Your Committee suggests, therefore, the adoption of the Ruffle method, on trial, for general fertiliser work for one year. You will in this case, we hope, prepare detailed directions for carrying out the said method.—Respectfully submitted,

Committee:—
Charles W. Dabney, Jr., Chairman.
W. E. Moses.
John A. Myers.

To the Official Agricultural Chemists' Association.

Results of the Determinations of Nitrogen in the Samples sent out by the Nitrogen Committee.

(1) An ordinary ammoniated superphosphate of the trade.

(2) An ordinary ammoniated superphosphate of the trade.

(3) Cotton-seed meal.

(4) Three parts sugar c.p. to 1 part nitre c.p. calculated 3·47 per cent nitrogen or 3·38 nitrogen by the absolute method.

The Ruffle Method for Nitrogen, as proposed by the Committee.

Reagents.—

(1) Standard sol. H_2SO_4. 0·019968 grms. SO_3 to 1 c.c. Everything depends on the correctness of this solution.

(2) Standard sol. KOH of exactly same strength as the acid.

(3) Soda-lime crushed so that one-half is powder and one-half in granules.

(4) Hyposulphite soda coml. fused, almost water free and powdered.

(5) Charcoal and sulphur, equal parts by weight of flowers of sulphur and finely powdered wood charcoal (N-free).

(6) Saturated sol. of "coralline" in alcohol.

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C. August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

RESULTS EXPRESSED AS NITROGEN.

By the Committee's Ruffle Method.

Analyst.	A.	B.	C.	D.	E.	F.	G.	H.	I.
1	1·78	1·85	1·66	2·10	—	1·66	1·93	1·80	1·69
2	2·04	2·15	2·00	1·99	—	2·07	1·80	2·12	1·92
3	7·45	7·53	7·43	7·56	—	7·48	7·05	6·35	7·50
4	3·36	3·40	3·30	2·45	3·37	3·49	3·45	3·44	3·05

By the Kjeldahl Method.

1	—	1·85	—	2·04	—	1·79	—	—	—
2	—	2·17	—	2·01	—	1·99	—	—	—
3	—	7·33	—	7·44	—	7·40	—	—	—
4	—	—	—	—	—	*2·38	—	—	—

By the Soda-Lime Method.

1	1·84	1·68	—	1·84	—	1·43	—	—	—
2	2·05	1·96	—	1·95	—	1·54	—	—	—
3	7·25	7·37	7·58	7·37	—	6·38	—	—	—
4	2·10	—	—	—	—	2·40	—	—	—

Apparatus.—

(1) Combustion furnace.

(2) U tube with stopcock.

(3) Two gallon bottles with syphon to aspirate.

(4) Combustion tube of best Bohemian glass, drawn to point, length 17½ inches; outside diameter ⅝ inch, inside diameter ½ inch.

Preparation.—

(1) Clean and fill U tube with 10 c.c. of SO_3 solution (or in proportion to the N expected).

(2) Fit cork and glass connecting tube (3), taking two sheets of letter-size paper No. 1 and No. 2; place on No. 1 two grms. powdered hypo., on No. 2 equal portions of soda lime and hypo., and mix. This mixture should be enough to fill 9 inches of the tube or about 15 to 20 grms. of each ingredient. Fill the tube as follows:—

(1) A plug of asbestos.

(2) One to one and a-half inches of hypo. and soda lime mixture from No. 2 paper.

(3) Mix intimately 1·4 grms. (or 0·7 or 2·8 grms., as is thought best) of the substance to be analysed with the powdered hypo. on No. 1; then add to the same 2 grms. of the C. and S. mixture; mix these thoroughly; next pour on No. 1 the mixture from No. 2, except enough to fill 1¼ inches of the tube; then mix carefully the mass now on No. 1 and pour into the tube; rinse off paper No. 1 with balance of hypo. and soda lime from No. 2.

(4) Knock down the contents of the tube as far as they will go; then further rinse off No. 1 with pure soda lime, and pour into the tube to within 1¼ inch of the end (space for swelling of the mass).

(5) Another plug of asbestos and cork.

(6) Holding the filled tube nearly horizontal, tap on table until there is a gas channel all along the top of tube as it will lie in furnace. Place in furnace and make connections. Aspirate and see that all is tight.

The Combustion—

Commence by heating the pure soda lime portion until it is a good red heat; then turn up slowly jet after jet toward the other end of the tube, so that the bubbles come off two or three a second. When the whole tube is red hot and all bubbles cease and the liquid in the U tube begins to recede towards the furnace, lower the flames somewhat, break off end of tube, and aspirate to extent of about one-half litre. Detach U tube, wash contents into a beaker, add five drops coralline solution and titrate.

Follow this scheme closely on committee's samples, criticise it, and suggest changes.

(To be continued.)

* 2·76 with benzoic acid; 2·41 with sucrose.

A METHOD FOR THE SEPARATION AND ESTIMATION OF BORIC ACID, WITH AN ACCOUNT OF A CONVENIENT FORM OF APPARATUS FOR QUANTITATIVE DISTILLATIONS.*

By F. A. GOOCH.

IN all successful methods for the estimation of boric acid its comparative isolation is a necessary preliminary. Fortunately the removal of nearly everything which interferes seriously with the proper execution of methods is not particularly arduous, but, of ordinarily occurring substances, two, silica and alumina,—both very commonly associated with boric acid,—are especially annoying in this regard. In the separation of alumina the trouble lies in the tendency of the precipitated hydrate to carry and retain boric acid,† so that the two cannot be parted by means of ammonia or ammonia salts; with silica, the difficulty is in removing it completely. The volatility of boric acid stands, of course, absolutely in the way of treating with acid and evaporating to dryness, and every chemist knows the vainness of attempting to precipitate silica by means of ammonia, ammonia salts, or zinc oxide in ammonia. In Stromeyer's method‡ the presence of silica is peculiarly harmful, since in passing to the condition of potassium fluosilicate this substance nearly quadruples its weight, and to free the potassium fluo-borate from containing fluo-silicate requires, according to Fresenius,§ at least six treatments by solution in boiling water, the addition of ammonia, and evaporation to dryness. Wöhler‖ recommends evaporating the hydrochloric acid solution to dryness in a flask fitted to a condenser, collecting the distillate, reuniting the latter with the residue, and filtering from silica; and the operation is successful so far as the complete removal of silica is concerned, but the alumina, if present, is still in condition to give annoyance, and the other bases are yet to be separated.

Advantage has long been taken of the volatility of free boric acid with hydrofluoric acid or with alcohol to secure its removal from fixed substances, but so far as I know no attempt has been made heretofore to secure its complete volatilisation and estimation in the distillate. The experiments which I proceed to describe are the result of an effort to accomplish this end.

Aside from the difficulties in manipulation and in the construction of apparatus which the use of hydrofluoric acid would involve, this reagent is otherwise plainly inapplicable to the purpose in view, and of other agents with which boric acid is known to volatilise freely methyl alcohol seems to present the most desirable qualities Methyl alcohol, ethyl alcohol, and water are effective in the order in which they are named. Thus, to volatilise 1 grm. of boric acid,—the equivalent, speaking roughly, of about 0·5 grm. of boric anhydride,—two treatments with 10 c.m.³ of methyl alcohol and evaporation to dryness in each case were adequate; for the volatilisation of 0·2 grm. of boric acid were required two treatments of 10 c.m.³ each of ethyl alcohol, succeeding an evaporation with 50 c.m.³ of the same alcohol; and the residue of five evaporations of water over 0·4 grm. of boric acid, taking in each case 50 c.m.³ of water, followed by ignition, weighed 0·08 grm., or one-fifth of the original weight. In the presence of water, methyl alcohol is not equally effective; amyl alcohol and sulphuric acid restrain its action similarly, doubtless by dilution simply, and hydrochloric acid seems to possess no advantage over water alone in developing the volatility of boric acid. As an example, an experiment may serve in which a solution of 0·4 grm. of

* *Proceedings of the American Academy of Arts and Sciences* 1886—87.

† Wöhler, *Ann. d. Chem. u. Pharm.*, cxli., 268.

‡ *Ann. d. Chem. u. Pharm.*, c., 82.

‖ "Quant. Chem. Anal.", p 424.

§ "Handbook of Mineral Analysis," under Datholite.

boric acid in 50 c.m.³ of water, after being heated three times successively with 25 c.m.³ of methyl alcohol until the boiling-point rose in every case nearly to that of water, and then evaporated to dryness, left a large residue which disappeared with a single charge of 25 c.m.³ of methyl alcohol applied by itself.

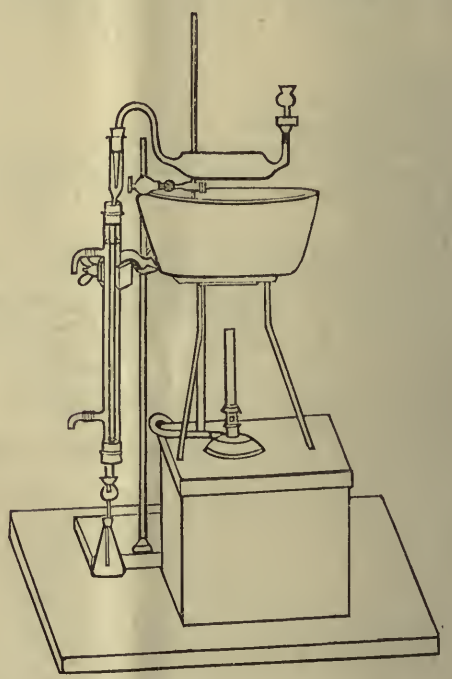
From the residue of the evaporation of borax with hydrochloric, nitric, or acetic acid, methyl alcohol, as would naturally be predicted, volatilises the boric acid freely, though the presence of foreign material acts to a certain degree protectively and tends to diminish the rapidity with which the alcohol would otherwise effect extraction and volatilisation. In case, however, that acetic acid is used to break up the borate, the tendency of sodic acetate to lose acid and become alkaline simply by exposure to evaporation in its aqueous solution makes it necessary to insure the acidity of the residue of evaporation by adding a drop or two of acetic acid before repeating the treatment with methyl alcohol.

On the whole, methyl alcohol shows itself to be an excellent agent by which to secure the volatilisation of boric acid.

To retain free boric acid, magnesium oxide naturally suggests itself. According to Marignac* it is effective, and, if in the course of analysis it may have been partly converted to the chloride, it is easily regenerated by the action of heat and moisture. Marignac, it will be remembered, makes use of magnesia mixture—the chlorides of ammonium and magnesium with free ammonia—to fix the boric acid, evaporating the solution to dryness, igniting, extracting with boiling water, filtering, and weighing the residue, while the filtrate is again treated as before to recover traces of the borate which have yielded to the solvent action of the water. During the drying and ignition the magnesium chloride yields hydrochloric acid, and it would seem scarcely possible that the magnesium borate should fail to show some loss of boric acid when both hydrochloric acid and moisture exert their action. Further, the presence of ammonia during evaporation does not prevent the volatilisation of boric acid,† and Marignac regards the addition of it from time to time as of doubtful use. So it appears natural to look for some loss under such conditions, and Marignac fully recognises the fact that the apparent accuracy of his method is due to the balancing of errors, the inclusion of foreign matter by the magnesium borate, and the deficiency of the magnesia when precipitated as ammonio-magnesium phosphate together compensating for the loss of boric acid by volatilisation. To bring the matter to the test, the following experiments were made. In them and in all succeeding experiments the boric acid was weighed in solution, the standard of this having been fixed by dissolving in a known weight of water a known weight of fused boric anhydride prepared in a state of purity by frequent recrystallisation. The magnesium oxide employed was made from the pure chloride by precipitating by ammonium carbonite and igniting, and was free from lime and alkalies, and as far as could be determined otherwise pure. The whole operation of each experiment was conducted in one vessel, so as to avoid transfers. In all cases a weighed platinum crucible of 100 c.m.³ capacity received a weighed portion of magnesia, and after ignition and subsequent weighing the weighed solution of boric acid was introduced. In experiments (1) to (4) the magnesia was thoroughly stirred in the solution of boric acid, the evaporation carried at once to dryness, and the crucible and residue ignited and weighed; in experiments (5) to (8), the magnesia was dissolved, after the addition of the boric acid, in hydrochloric acid sufficient in amount to prevent the precipitation of magnesium hydrate on the subsequent addition of ammonia, ammonia introduced in considerable excess in (7) and (8), in distinct excess in (5) and (6), the whole evaporated and ignited, the residue moistened and again ignited, and this last treatment repeated until the residue ceased to yield vapour of hydrochloric acid when heated.

	B_2O_3 taken. Grm.	MgO taken. Grm.	$MgO+B_2O_3$ found. Grm.	B_2O_3 found. Grm.	Error. Grm.
(1)	0·1734	0·5005	0·6607	0·1602	0·0132 –
(2)	0·1804	0·4973	0·6660	0·1687	0·0117 –
(3)	0·1793	0·4949	0·6640	0·1691	0·0102 –
(4)	0·1794	0·4941	0·6627	0·1686	0·0108 –
(5)	0·1807	0·4984	0·6542	0·1558	0·0249 –
(6)	0·1789	0·4974	0·6687	0·1560	0·0229 –
(7)	0·1806	0·4944	0·6684	0·1740	0·0066 –
(8)	0·1789	0·4959	0·6672	0·1713	0·0076 –

From these results it appears plain that under the conditions of the experiments neither magnesia alone nor the magnesia mixture is efficient in fixing boric acid; but in experiments (7) and (8), in which ammonia was employed in large excess, the loss of boric acid is least, so that it



would seem to be the case that though ammonia is not a perfect preventive of volatilisation it does exert a restraining action on the boric acid. That the magnesia mixture should be incapable of retaining entirely the boric acid present is, as has been pointed out, not surprising; but that the loss should be so great is rather startling, and more than suggests that the errors of Marignac's process are seriously excessive. The failure of magnesium oxide to hold back boric acid under the conditions of the experiment must be due to a cause other than that which determines the loss during the evaporation and ignition of the magnesia mixture, and for this it is natural to turn to the insolubility of the oxide—a quality likely to oppose some difficulty in the way of establishing complete contact between the boric acid and the magnesia during a short exposure. Direct tests of this point showed distinctly that mixtures of boric acid in water and magnesia, when submitted at once to distillation, yielded boric acid to the distillate; but that, if the mixtures were permitted to stand some hours before distilling, the oxide passed to the semi-gelatinous condition of the hydrate, and retained the boric acid so firmly that turmeric failed to show the

* *Zeit. für Anal. Chem.*, i. 406
† Rose, *Pogg. Ann.*, lxxx., 262

presence of the latter in the distillate. It is plain, therefore, that with sufficient preliminary exposure magnesia might be relied upon to retain boric acid; but inasmuch as long and perhaps somewhat indefinite periods of waiting are objectionable in any analytical process, it was thought best to try the effect of substituting lime for magnesia. Experiments (9) to (12), conducted like the previous ones, excepting only the use of carefully prepared and ignited calcium oxide instead of magnesium oxide, were made with this end in view.

	B_2O_3 taken. Grm.	CaO taken. Grm.	$CaO+B_2O_3$ found. Grm.	B_2O found. Grm.	Error. Grm.
(9)	0·1810	0·9737	1·1560	0·1823	0·0013+
(10)	0·1819	0·9750	1·1583	0·1833	0·0014+
(11)	0·1808	0·9922	1·1810	0·1818	0·0010+
(12)	0·1833	0·9715	1·1560	0·1845	0·0012+

These figures indicate sufficiently that there is no loss of boric acid by volatilisation when its aqueous solution is evaporated in contact with calcium hydrate; but, inasmuch as the comparative solubility of the latter is the quality which makes it effective where magnesia is not, it seemed desirable to test the action of calcium hydrate in alcoholic solutions, in which it is very insoluble. The experiment showed that when the solution of boric acid in methyl or ethyl alcohol is put upon lime and distilled at once loss is apt to take place, and sometimes to a very considerable amount, but that a short period of digestion with occasional stirring—from five to fifteen minutes—is sufficient to obviate danger of volatilisation of boric acid.

It appears, therefore, that free boric acid being easily volatilised by means of methyl alcohol and fixed completely by calcic hydrate, the separation of the acid from almost everything with which it occurs ordinarily and its estimation subsequently depend only upon the practicability of distilling it from its compounds in such company that it may be retained by lime and its amount determined by the increase in the weight of the latter. Unlike magnesium chloride, calcium chloride does not yield its chlorine readily under the action of heat and moisture naturally retained; so that hydrochloric acid must not be present with boric acid which is to be estimated in the manner described. Calcium nitrate and calcium acetate both yield the oxide without difficulty upon ignition, and nitric and acetic acids are suitable agents, therefore, for the liberation of boric acid previous to distillation.

The actual distillation presented at first some difficulty—for the repeated, thorough, and rapid evaporation of a liquid charged with soluble or insoluble solid matter is apt to involve some mechanical transfer to the distillate of material which should remain in the residue—but the device of the following description solves the problem successfully.

The apparatus, which is shown in the accompanying cut, consists essentially of a retort, condenser, and bath for heating. For the last I have used a paraffin bath, as being on the whole the most convenient. The condenser is set vertically, to facilitate changing the level of the retort within the bath, and to secure at the same time continual and thorough washing of the tube by its own condensations. The retort, somewhat like the well-known drying tube of Liebig in general shape, is easily made of a pipette by bending the tube at one end to a right angle, at the other to a goose-neck, as shown. To the former end is fitted, by a rubber stopper or section of tubing, a glass funnel-tube provided with a stop-cock; the end of the goose-neck passes tightly through a rubber stopper in the upper end of the condensing tube. This is essentially the apparatus, but it is convenient to attach to receive the distillate a small Erlenmeyer flask which moves with the condenser and is joined to it, in the manner indicated in the figure, by means of a thistle-tube and a rubber stopper grooved to permit the free passage of air. In carrying out a distillation, the liquid to be distilled is introduced into the retort either by the funnel-tube or previous to its insertion, the glass cock is closed, the water started through the condenser, and the retort lowered into the hot paraffin, care being taken to begin the operation with the retort not more than half full and so inclined that only the rear dips below the surface of the bath. If the precaution to heat the retort at the start in this manner be overlooked, it may sometimes happen that the sudden and violent expulsion of the air through the liquid will carry portions of it bodily into the goose-neck, and even into the condenser. With this point considered, the remainder of the operation presents no difficulty, and requires little care.

The size of the retort may be suited, of course, to the particular case in hand, but for most purposes a 200 c.m.³ pipette makes a retort of convenient dimensions, neither too large for the distillation of small charges nor too small to permit the treatment of 100 c.m.³ of liquid comfortably. The tube of the goose-neck should be wide enough to prevent the formation of bubbles in it; 0·7 c.m. is a good measure for the interior diameter. It is of advantage to heat the bath to a point considerably above the temperature at which the liquid which is to be distilled boils,—something between 130° C. and 140° C. does very well for water, and is not too high for methyl alcohol,—and under such circumstances, and when the retort is entirely submerged, it often happens that evaporation takes place with extreme rapidity from the surface of the liquid in perfect quiet without actual boiling.

With such an apparatus the following experiments were made. The boric acid was weighed, as before, in solution, and to bring the condition of the experiment to that of an actual analysis, 1 grm. of pure sodium hydrate was added in solution, nitric acid or acetic acid to acidity and a little more, and the whole was introduced into the retort and distilled to dryness.

In those experiments in which nitric acid was employed, the methyl alcohol was introduced upon the residue thus dried in six successive portions of 10 c.m.³ each, and distilled to dryness; but in order to break up the residue of sodium nitrate, which by its insolubility might effect to some extent the protection of the boric acid from the action of the alcohol, 2 c.m.³ of water were introduced and evaporated between the second and third, and again between the fourth and fifth distillations.

When acetic acid was made use of to free the boric acid, the six distillations with methyl alcohol were made as before; but, sodium acetate being soluble in methyl alcohol, the intermediate treatments with water were unnecessary. With the fourth portion of methyl alcohol a few drops of acetic acid were added to preserve the acidity of the residue, which, as has been pointed out, tends to become alkaline under the treatment.

The residues of both processes of treatment were found to be free from boric acid by the exceedingly delicate test with turmeric, care being taken in the series of experiments in which nitric acid was used to oxidise nitrites by means of bromine (expelling the latter before making the test), and in the acetic acid series to acidify with hydrochloric acid sufficiently to counteract the tendency of the acetate by itself to brown the turmeric on evaporation.

The lime to retain the boric acid in the distillate was ignited in the crucible in which the evaporation of the distillate was to be made subsequently, and then transferred to the receiving flask attached to the condenser, so that the boric acid might be fixed during the distillation. To prevent the caking of the lime by the action of the alcohol, it was slaked with a little water before the distillation was begun.

In experiments (13) to (16) nitric acid was employed, and in (17) to (20) acetic acid was used, with the precaution noted, to liberate the boric acid.

In experiments (13) to (16) the mean error amounts to 0·0012+ grm.; the experiments (17) to (20) the mean error is a little more than 0·0010+ grm. Throughout the entire series of experiments the tendency to yield

	B_2O_3 taken. Grm.	CaO taken. Grm.	B_2O_3+CaO found. Grm.	B_2O_3 found. Grm.	Error. Grm.
(13)	0·1738	0·9647	1·1392	0·1745	0·0007+
(14)	0·1806	0·9639	1·1456	0·1817	0·0011+
(15)	0·1779	0·9665	1·1450	0·1785	0·0006+
(16)	0·1824	0·9739	1·1587	0·1848	0·0024+
(17)	0·1806	1·4559	1·6371	0·1812	0·0006+
(18)	0·1812	0·9720	1·1543	0·1823	0·0011+
(19)	0·1788	0·9986	1·1781	0·1795	0·0007+
(20)	0·1813	0·9527	1·1358	0·1831	0·0018+

figures slightly larger than the truth is manifest, but the error is quite within legitimate limits. The greatest care was taken to secure similarity of conditions under which the crucible and lime were weighed before and after the evaporation and absorption of boric acid, and the weight after ignition was taken in every case after cooling over sulphuric acid during a definite period of ten minutes in order to eliminate as far as possible the effect of atmospheric condensation upon a large surface of platinum. Ignitions were always finished over the blast-lamp, and constancy of weights secured.

The results of both modes of treatment are, on the whole, satisfactory, and equally so.

In the presence of chlorides, it is of course impossible to employ nitric acid to free the boric acid. Oxalic, citric, and tartaric acids also liberate hydrochloric acid to a considerable extent from alkaline chlorides. It was found, however, that when acetic acid was distilled over sodium and potassium chlorides only traces of hydrochloric acid passed into the distillate, and experiments (21) to (23) were made to determine whether these amounts are sufficient to vitiate the separation of boric acid from alkaline chlorides by distillation in the presence of free acetic acid. The details of treatment were identical with those of experiments (17) to (20), excepting only the addition of 0·5 grm. of sodium chloride to each portion before distillation.

	B_2O_3 taken. Grm.	CaO taken. Grm.	B_2O_3+CaO found. Grm.	B_2O_3 found. Grm.	Error. Grm.
(21)	0·1834	0·9842	1·1675	0·1833	0·0001 −
(22)	0·1831	0·9755	1·1593	0·1838	0·0007+
(23)	0·1761	0·9740	1·1523	0·1783	0·0022+

The mean error of these results is about 0·0009+ grm. and it is plain that the presence of sodium chloride does not materially change the conditions of the experiment. There seems, therefore, to be no reason why boric acid may not be separated by distillation from alkaline chlorides in presence of free acetic acid; but it was found that the presence of any considerable amount of potassium acetate is disadvantageous. Sodium acetate to a reasonable amount does not interfere with the favourable progress of the separation; but potassium acetate appears to require a much higher temperature for the expulsion of its water, and longer distillation.

When, therefore, chlorides are present in the salts from which boric acid is to be removed by distillation, the choice is open between two methods: the distillation may be made directly with an excess of acetic acid; or the hydrochloric acid may be first removed by means of silver nitrate, and the distillation of the filtrate proceeded with at once, or after precipitation of the excess of silver salt by means of sodium hydrate or carbonate, care being being taken to acidify again sufficiently with nitric acid after the removal of the silver. Of these two modes of proceeding, I incline to the treatment with nitric acid and the removal of the chlorine by precipitation; and this method has been used with success by others as well as myself, for some months, in the analysis of waters carrying boric acid, and natural borates.

The process in either modification is fairly accurate and easily executed, and admits of very wide application. Insoluble compounds in which the boric acid is to be determined may be dissolved in nitric acid at once, or, if necessary, first fused with sodium carbonate; and, fortunately, nearly everything which is volatile in the subsequent treatment and capable of forming with lime compounds not easily decomposable by heat may be removed by known processes. The combination of fluorine, silica, and boric acid is perhaps most difficult to treat; but the precipitation and removal of the first as calcium fluoride from the aqueous solution of a fusion in alkaline carbonate may, it is believed, be effected with care, and the mode of procedure from that point is simple.

The number of distillations necessary depends, of course, upon the amount of boric acid treated. To remove 0·2 grm. of boric anhydride completely to the distillate, six charges of methyl alcohol, of 10 c.m.³ each, proved, as we have seen, to be ample.

The apparatus by the aid of which the distillation processes which have been described were carried out has found useful application in a number of other processes. In the determination of free and albumenoid ammoniai in waters which can be boiled quietly with difficulty, in the methods of estimating hydrofluoric acid which involve the expulsion of silicon fluoride from a mixture of the fluoride with sulphuric acid and silica, in the separation of iodine from bromides and chlorides by distilling with ferric sulphate and sulphuric acid, and of bromine from chlorides by means of permanganic acid, it has proved of value, and will doubtless be found convenient in many analytical processes in which quantitative separations by the distillation of liquids liable to spatter or boil explosively are involved.

PROCEEDINGS OF SOCIETIES.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

On November 10th, 1886, a meeting of intercolonial delegates was held at the Royal Society's Rooms, Elizabeth Street, for the purpose of forming an Australasian Association for the Advancement of Science. The following delegates were present:—Victoria: Field Naturalists' Club of Victoria, the Rev. Dr. Woolls, F.L.S.; Geological Society of Australasia and Historical Society of Australasia, Mr. R. T. Litton, F.L.S.; Royal Society of Victoria, Mr. K. L. Murray; Victorian Institute of Surveyors, Messrs. W. J. Conder and W. H. Nash; Victorian Engineering Association, Professor Kernot, M.A., and Mr. K. L. Murray. Queensland: Geographical Society of Australasia, Queensland Branch, Mr. J. P. Thompson, M.A., C.E.; Royal Society of Queensland, Mr. Henry Tryon. Tasmania: Mr. James Barnard. New Zealand: Philosophical Institute of Canterbury, Mr. S. Herbert Cox, F.C.S., F.G.S. New South Wales: Linnæan Society of New South Wales, Professor Stephen, M.A.; Royal Society of New South Wales, Mr. H. C. Russell, B.A., F.R.S., Professor Liversidge, F.R.S., Mr. C. S. Wilkinson, F.G.S., F.L.S.; New South Wales Zoological Society, Dr. A. T. Holroyd, F.L.S.; Sydney Branch of the Geographical Society of Australasia, and Sir Edward Strickland, K.C.B., F.R.G.S. In the absence of Mr. C. Rolleston, C.M.G., President of the Royal Society, Mr. Russell was voted to the chair.

Professor Liversidge, in response to a request from the Chairman, explained that the object of the meeting was the formation of an Australasian Association for the Advancement of Science, and he supposed they had all received a circular setting that object forth. Their business was to frame conditional rules, and to appoint a date for the first meeting in 1888, that year having been partly fixed upon because it was the hundredth anniversary of this colony, and when this subject was proposed it

was thought there would be an exhibition here that year, and therefore a good time for the meeting of scientific men.

The Chairman said the first resolution had been put down on the business paper to be proposed by Mr. Rolleston, but he (the Chairman) was bound to move it in that gentleman's absence. It was one about which he thought there could not be much question. The resolution was,—"That an association of the scientific societies of Australasia be formed under the name of 'The Australasian Association for the Advancement of Science.'" There had been heretofore in these colonies a great want of united action, and many subjects which might have been taken up had not been. It was therefore desirable that they should, by every means in their power, form associations for the furtherance of investigation. There were many objects for investigation which men coming from the civilised world took the honour and credit of studying that might otherwise belong to this colony. The formation of the Association would be the means of stirring them up to do work which they had hitherto left undone.

Sir Edward Strickland seconded the motion, which was unanimously carried.

Profassor Stephen moved,—"That the rules of the British Association as printed shall be adopted by the Australasian Association for the Advancement of Science, and such other rules of the British Association be followed as may be necessary until the first meeting of the Australasian Association."

Mr. J. P. Thompson seconded the motion, which was carried unanimously.

Professor Kernot moved—"That the President, Hon. Secretaries, and Hon. Treasurer shall be elected annually by ballot from amongst the representatives of the colony in which the meeting is to be held. The first election of officers shall be held in Sydney in March, 1888." He said that the three bodies with which he had the honour of being connected in Victoria had all received the proposal for the formation of an Australasian Association for the Advancement of Science with the greatest heartiness. No one had any shadow of misgiving as to the thing being good, and the sooner it was done the better. He took that opportunity of assuring the scientific gentlemen present that the three bodies he represented gave this scheme of federation of the scientific societies their hearty adherence, and would be most happy in every possible way to assist at the meeting of the Association which he trusted would be held in 1888.

Mr. R. T. Litton seconded the motion.

After some conversation the motion was carried unanimously.

Mr. Cox moved—"That the first meeting of the Association be held in the first week in September, 1888."

Mr. Conder seconded the motion, which was carried unanimously.

Moved by Mr. Tryon and seconded by Mr. Murray, it was unanimously resolved that Professor Liversidge be appointed convener for the next meeting, and a hearty vote of thanks was accorded to that gentleman for the part he had taken towards the formation of the new Association, general satisfaction being manifested at the successful result of the meeting.

A vote of thanks to the Chairman terminated the meeting.

Dr. Divers, F.R.S.—The Queen has been pleased to give and grant unto Edward Divers, Esq., M.D., F.R.S., Principal and Professor of Chemistry at the Imperial College of Engineering, Tokio, Her Majesty's Royal license and authority that he may accept and wear the insignia of the Order of the Rising Sun of the Third Class, which His Majesty the Emperor of Japan has been pleased to confer upon him in recognition of his services while actually and entirely employed beyond Her Majesty's dominions in His Imperial Majesty's service.

NOTICES OF BOOKS.

Letts's Diaries for 1887. Cassell and Co., Limited, London, Paris, New York, and Melbourne. 1886.

Letts's Diaries are so well known to, and appreciated by, the public in general, and have held the foremost position for so long, that it is almost superfluous to say anything more than that they are quite up to the usual standard of excellence. The "Universal Diary" is very convenient for office use, though hardly large enough for the laboratory; the diaries can, however, be obtained in all sizes, to suit every requirement.

CORRESPONDENCE.

THE ACTION OF FUMING SULPHURIC ACID ON ALPHA-NAPHTHYLAMINE.

To the Editor of the Chemical News.

Sir,—It may be interesting to many of your readers, and more especially those engaged in the chemical industries, to refer to a matter that has just come under my observation.

On glancing through the second edition of the well-known German work of Dr. G. Schultz, "On the Chemistry of Coal Tar," &c., a work acknowledged to be the best in any language on the subject with which it deals, I lighted on a passage of which I beg to subjoin a translation; this passage will be found at the foot of page 513 and top of page 514, with appended footnote on page 514, in the third part of the first volume of the work in question. "In the German Patent, No. 5411 of the Badische Anilin and Soda Fabrik, the preparation of sulphonic acids of *a*-naphthylamine difficult of solubility is referred to. This preparation is accomplished either by sulphonating the naphthylamine with fuming acid (1 part of naphthylamine with 3 parts of fuming sulphuric acid of 80 per cent!) (the note of admiration is Dr. Schultz's) at 70° to 80° C., or by reduction of the nitronaphthalene-sulphonic acid by means of iron, which sulphonic acid had been prepared from 1 part of nitronaphthalene, 2 parts of ordinary, and 1 part of fuming sulphuric acid of 80 per cent of anhydride." Dr. Schultz has appended a footnote to the statement as regards the use of the fuming sulphuric acid of 80 per cent strength (3 parts) to be used upon the *a*-naphthylamine (1 part) at 70° to 80° C.

This footnote, literally translated, runs as follows:—"Here is evidently a printer's error, for *a*-naphthylamine is completely destroyed by such an acid." Looking, however, at the English patent, "a communication" from the patentees abroad, I find literally the same description, "One part by weight of naphthylamine (which naphthylamine is not stated) is mixed with about three parts by weight of fuming sulphuric acid containing about 80 per cent of anhydrous sulphuric acid, and the mixture is heated at a temperature of about 70° to 80°," &c.—I am, &c.,

Watson Smith, F.C.S., F.I.C.,
Lecturer in Chemical Technology in the Victoria University, &c.

NICKEL LABORATORY UTENSILS.

To the Editor of the Chemical News.

Sir,—I have been less fortunate than Mr. Wanklyn in my experience with nickel as a material for crucibles. Soon after I heard that such vessels could be obtained I bought a small crucible, price 2s. 6d., and made a few simple experiments with its lid. I find in my notes:—

Over a good Bunsen flame—

Weight of polished lid	13·045	grms.
,, after ignition	13·048	,,
,, ,, further heating ..	13·040	,,
,, ,, ,, ,, ..	12·978	,,

A brownish film appeared on the lid, which thickened till almost black flakes were formed, which adhered but loosely to the metal underneath them, and were brushed off before weighing.

Suspecting that these flakes contained carbon, and that their formation was due to the contact of the nickel with that part of the flame containing unoxidised bodies, I removed the lid to the extreme tip of the Bunsen flame, when after it had remained there one hour it had gained 2 m.grs. and weighed 12·980 grms. It was again heated for one hour in the same position, and its weight remained constant.

Its behaviour with reagents was then tried.

(1.) Nitre—

Weight after 15 minutes fusion	12·992
,, ,, 30 ,, ,, ...	13·042

The surface was blistered and evidently oxidised, as shown by the considerable gain in weight, but the nitre contained no nickel.

(2.) Caustic potash—

Weight of lid after cleaning	12·9725	grms.
,, ,, ,, 10 minutes fusion	12·9723	,,

No nickel was detected in the potash.

(3.) Potassium cyanide—

Weight after 10 minutes fusion.. 12·9226 grms.

The potassium cyanide contained nickel.

The crucible itself was afterwards heated in a gas muffle; it became covered with loosely adhering scales of a beautiful lustre, like polished black-lead, on the outer side, and of a rough texture and grey-green hue on the other.

According to the foregoing experiments the uses of nickel for chemical purposes are confined to—

(i.) Dry ignitions (*i.e.*, not fusions) in an oxidising flame, provided the heat be not too intense.

(ii.) Fusions with caustic alkalies.

From which may probably be deduced—

(iii.) Fusions with barium hydrate.

(iv.) Fusions with alkaline carbonates.

This is surely an ample field for it, and it is, as Mr. Wanklyn points out, worthy of the chemist's further attention; but its inability to stand high temperatures, especially in contact with a reducing flame, limits its employment considerably, and demands caution in dealing with it.

It is just possible that the crucible and lid which I used were not a fair sample, and that their behaviour was due to some peculiarity; the experience of others under like conditions would elucidate this point.—I am, &c.,

BERTRAM BLOUNT.

23, Queen Anne's Gate, S.W., Jan. 4, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Biedermann's Central Blatt für Agrikultar Chemie.
Vol. xv., Part 7.

Sulphuric Acid as a Manure.—Professor Farsky.—The author caused the strongest acid to act upon earth, mixing it frequently, and applied this compost to a field, whilst other lots were mixed at once with stro g acid, and others again with dilute acid. The direct influence of sulphuric acid upon the soil was favourable, but the yield was higher the more dilute the acid. If the cost of the acid is taken into account the apparent advantage of this manuring disappears.

On Lactina.—Professor F. Fleischmann.—A Hamburg firm offer a vegetable food for young animals under the name of "lactina"—said to be a perfect substitute for their mother's milk. It contains the meal of a leguminous seed. It is less costly than milk, but far poorer in proteine, fat, and mineral salts.

The Feeding Value of Sorghum.—W. Fersman and Professor Farsky.—Not adapted for useful abstraction.

Solution of Starch in Leaves.—Leon Brasse.—The author has detected in leaves a kind of diastase, known as amylase, which converts starch into a reductive sugar. This result has been confirmed by Schimper. He has now undertaken a comparison between amylase and malt-diastase.

The Formation of Starch Granules in Leaves from Sugars, Mannite, and Glycerine.—Arthur Meyer.—This paper is botanical rather than chemical in its import.

On a Quantitative Determination of the Chlorophyll Pigment in Leaves.—A. Hansen.—The leaves were extracted for a short time at a boil, the colouring matter dissolved out in alcohol at 96 per cent, the solution saponified, dried, and weighed after the expulsion of the solvent. The yellow and the green chlorophyll were not separated. Five parts of chlorophyll are engaged in the formation of 25 parts of starch.

Extirpation of the Root-Fungus (Dematophora Necatrix) in Vineyards.—Professor L. Just.—Naphthalin is not capable of destroying this fungus or of keeping it from attacking healthy vines. Vine-props soaked with creosote are also useless, and are themselves overgrown with the fungus.

Analytical Detection of so-called "Saccharine."—H. Reischauer.—One hundred grms. of sugar are let stand for some hours in a closed vessel with 150 to 200 c.c. of ether, shaking frequently. If a sample of sugar has an alkaline reaction a strong aqueous solution is used instead of solid sugar; it is slightly acidified with phosphoric acid and then shaken out with ether. The ethereal solution is then drawn off with a syphon and filtered. In both cases the ether takes up a large part of the saccharine, which is obtained in the residue, after distilling off the ether, almost free from sugar. The presence of saccharine is best demonstrated by cautiously heating the residue in a platinum crucible with a mixture of 6 parts pure sodium carbonate and nitre, and finally igniting, not too strongly. Saccharine contains sulphur, which is thus completely converted into sulphuric acid.

Moniteur Scientifique, Quesneville.
3rd Series. Vol. xvi., October, 1886.

The Purple of the Solar Spectrum, the Synthesis of Red and Colouration in General.—M. Camille Kœchlin.—Already inserted.

Patents concerning Colouring Matters, taken out in Berlin.—M. No. 4257. Monnet & Co., of La Plaine, April 6th, 1886.—Production upon the fibre itself, of greys more or less inclining to a blue or a brown by the simultaneous oxidation of aromatic monamines and diamines.

D. No. 2505. A. Dahl, February 17th, 1886. Process for preparing the disulphonic acids of mono-, di-, or tribenzylrosaniline.

W. No. 4039. A. Wulsing, March 1st, 1886. Separation of paratoluidine from orthotoluidine.

C. No. 1727. L. Casella. April 5th, 1886.—Preparation of blue-black azo-colours.

B. No. 6665. Baden Aniline Works. April 19th, 1886.

Preparation of a new yellow colour, galloflavine, by means of gallic acid.

B. No. 6511. C. F. Bœhringer. February 22nd, 1886. Preparation of orthonitroamidoparametoxylbenzine.

On the Infusion of Tea.—W. M. Green.—From the CHEMICAL NEWS.

The Deposits of the Delta of the Nile.—Sir W. Dawson.—From *Nature*.

Krakatoa.—Mr. Johnston Lavis.—From *Nature*.

Method of Filtration by means of Filters readily Soluble and Volatile.—F. Gooch.—From the *American Chemical Journal*.

Solubility of Barium Sulphate in Hydrobromic and Hydrochloric Acids.—A Haslam. — From the CHEMICAL NEWS.

Volumetric Method for the Determination of Alumina.—Dr. J. Beyer.—From the CHEMICAL NEWS.

Adulteration of Olive Oil.—From the *Pharmaceutical Journal*.

On Water of Crystallisation.—W. Nicol, D.Sc.—From the CHEMICAL NEWS.

The Proportion of Moisture which Sulphuric Acid leaves in Gases.—E. W. Morley.—From the *American Journal of Science*.

Valuation by Distillation of Acetic Acid in Liquids containing Organic Matters.—H. W. Wiley.—From the CHEMICAL NEWS.

Optical Properties of Malic and Tartaric Acids.—Louis Bell.—From the *American Chemical Journal*.

The Temperature of Dissociation with Reference to Pyrotechnical Questions.—F. Siemens.—A lecture delivered before the Royal Institution.

Formation and Decomposition of Nitrates and Nitrites in Artificial Solutions and in Spring and River Waters.—J. H. Munro.—From the *Journal of the Chemical Society*.

The Centenary of M. Chevreul.—An account of the proceedings at the Museum, at the Hotel de Ville, and at the Odeon.

Discussion on the Fortification of Wines before the Academy of Medicine.—Continued from the September issue.

Industrial Society of Mulhouse. Session of the Chemical Section July 14th, 1886.—M. C. Kœchlin spoke of the formation of Schweinfurt green obtained by treating copper arsenite with acetic acid or copper acetate with arsenious acid or any salt of copper with an alkaline arsenite and then with acetic acid. Koechlin finds that by substituting formic acid for acetic acid we obtain a green fully as beautiful and bright. If only the half proportion of formic acid is taken there is obtained a pale blue which cannot be produced with acetic acid. Of all the elements arsenic is the one which can find the most varied applications in dyeing and printing whilst the dangers attending its use have been very much exaggerated. M. O. Scheurer announced that he had succeeded in superseding the use of alkaline arseniates in dunging puce mordants by the direct addition to the colour of phosphorous or hypophosphorous acids along with a salt of copper. He sent in a series of swatches which "confirm his assertions." Nevertheless the best swatch was one which had been treated with arsenious acid and copper chloride. M. Setlick, chemist at the Thann Chemical Works, sent in a paper on a process for determining the double antimony and potassium oxalate which has recently come into use for fixing tannin. Into the solution of this salt there is poured a standard solution of soda until a slight turbidity appears. The alkali employed shows the free oxalic acid present. Phenolphthaleine is then added, upon which antimony hydroxide has no action, and the liquid is titrated until an alkaline reaction appears, thus obtaining the quantity of antimony oxide. To determine the alkali a fresh portion is precipitated with ammonia, filtered, the liquid evaporated to dryness, ignited, and the alkaline carbonate thus obtained is titrated with normal acid. M. Prud'homme sent in a paper on some derivatives of β-amidoalizarine. On condensing β-amidoalizarine with phthalic anhydride, a new colouring matter is obtained which dyes a reddish-brown on aluminous mordants. M. Weingaertner sent in a synoptical table of the reactions of the principal artificial colouring matters.

Immisch Thermometers.—From *Nature*.

Volumetric Determination of Sulphates without Standard Solutions.—H. Quantin.—This paper will be inserted in full.

November, 1886.

Patents Granted at Berlin relating to Tinctorial Substances.—These include a process for obtaining red colouring matters by the combination of β-nepthylamine, β-sulphonic acid with the diazo-derivatives, by Leopold Casella and Co.; azo-colours depending on the previous patent, P.R. No. 28,753, by the Berlin Aniline Company; preparation of rich anthracenes from pitch containing anthracene, by Messrs. Remy and Ehrhardt; preparation of tetrachlorobromic or tetrachloriodic pyrols, by Kalle and Co.; preparation of napthylamine sulphonic acids and of substituted napthylamines, by the Berlin Aniline Co.; improvement in the preparation of auramines, by the Baden Aniline Co.; preparation of a blue-black azo-colour, by the Berlin Aniline Co.; preparation of a dry alizarin which can be easily re-converted into a paste, by Leverkus and Son; preparation of the salicylic ethers of the phenols and naphthols, by Prof. Nencke and Dr. von Heyden; preparation of napthaline trisulphonic acid, and its conversion into napthol-disulphonic acid.

German Review.—M. G. Serracin.—A series of extracts from the *Berichte der Deutschen Chem. Gesellschaft*.

Petroleum and its Products.—Boverton Redwood.—A paper read before the Society of Arts.

A Method of Illustrating the Periodic Law.—Prof. J. Emerson Reynolds, F.R.S.—From the CHEMICAL NEWS.

On Pseudo-Morphine.—M. O. Hesse.—From *Liebig's Annalen*, and already noticed.

MEETINGS FOR THE WEEK.

MONDAY, 10th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 11th.—Institution of Civil Engineers 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
WEDNESDAY, 12th—Geological, 8.
—— Microscopical, 8.
THURSDAY, 13th.—Royal, 4 30.
—— London Institution, 6.
—— Mathematical, 8.
—— Telegraph Engineers, 8.
FRIDAY, 14th.—Astronomical, 8.
—— Quekett Club, 8.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Test for Nitronaphthalin.—Can anyone indicate a test for the above in heavy mineral oils, where it is used for de-blooming, and is present to the extent of 1 to 3 per cent?—O. B.

TO CORRESPONDENTS.

Works Chemist.—The letters F.C.S. mean Fellow of the Chemical Society. Write to the Secretary of the Chemical Society, Burlington House, W.

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THE CHEMICAL NEWS.

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MODE OF DISTINGUISHING HORSEFLESH FROM BEEF.

By JAMES BELL, D.Sc., F.R.S.

IT having been alleged, in connection with a suggestion for legislation, that it was impracticable to distinguish by any ordinary method of analysis between horseflesh and beef, the question was submitted to me for report as to how far the statement was founded on fact.

As the result of a careful search for information, I found that very little had been done in this country on the subject, but I succeeded in obtaining some useful information from Paris as to the nature of the evidence upon which the Inspector of Slaughter-houses there, relies for distinguishing horseflesh from beef.

The characters relied on are as follows :—

1. Horseflesh is reddish brown, more or less dark, according to the quality, and gradually becomes darker when exposed to the air.
2. It has an odour peculiar to itself.
3. It is soft and but slightly tenacious, and the finger sinks easily into it. On working up the fibres a little, they break up and become pulpy.
4. The muscular fibres are long and fine, and united by very compact cellular tissue.
5. In cooking, horseflesh hardens and becomes more dense and compact than beef.
6. Under the microscope the fibres and striations of the muscular tissue are finer than in the flesh of the ox.

In a "Treatise on the Inspection of Butcher's Meat," by Baillet, and published by Asselin, of Paris, there is a comparative table showing the distinctive physical and anatomical characters of the flesh of the ox, cow, and horse, and it may be useful to give the table, of which the following is a translation :—

	Flesh of		
	Ox.	Cow.	Horse.
Colour	Bright red.	Bright red.	Dark red.
Consistence	Firm, hard, often even tough.	Firm, but soon becomes tender and unctuous.	Firm, hard, tough.
Cut	Resistant and large grain. Not mottled.	Easy and fine grain. Mottled.	Resistant, large grain. Not mottled.
Odour	Fresh, only that of beef.	Fresh, aromatic.	Musk-like.
Fat	No covering fat. Interior fat white.	Covering fat white or yellowish.	No covering fat. Interior fat white and firm.
Articular surface	Rosy white.	Rosy white.	Deep rose.
Anatomical constitution	Muscular bundles with fibres smooth, long, and united by conjunctive tissue, loose, easily penetrated by the fat.	Muscular bundles more compact, more resistant. Conjunctive tissue loose or compact, according to the quality.	Muscular fibres short, crowded in long and thin bundles.

These characters, which are purely physical and anatomical, appeared to me likely to enable an experienced person to form, from a careful inspection of the meat, a fairly reliable opinion as to its origin.

With the aid, therefore, of the table and the characters described above, we examined a large number of specimens of horseflesh and beef, but we failed to observe such sharply defined differences in their respective characters as would enable us to positively identify and distinguish the former from the latter.

In these circumstances it became necessary to seek in other directions for evidence of a more positive kind, and attention was directed to the fats, a point which appears to have escaped the notice of previous experimentalists.

It was observed that the adipose tissue of the horse was of a softer and more oily nature than that of beef, and it was thought that in this difference there might be found a solution of the problem.

A series of experiments was first made with the adipose tissue collected from different parts of the horse-flesh, such as the round, flank, ribs, kidneys, and heart. The fat was cut up into small pieces and placed in a glass beaker, which was heated in a water-bath until the whole of the fat was melted. The melted fat was then poured off while hot, and its sp. gr. taken at 100° F.

The fat which was first experimented upon was that collected from the round, and it was found to have a sp. gr. of 908·8. Like experiments were made with the portions of fatty tissue collected from the other parts above named, and the specific gravities of the melted fats only varied from 908·6 to 908·7, the results thus practically agreeing with the specific gravity of the fat obtained from the round.

It next became necessary to determine whether the fat contained in the lean portion of the meat corresponded in specific gravity with that derived from the adipose tissue. For this purpose a portion of the horseflesh, which was freed from all fatty tissue, was cut into small pieces and stewed with water, the fat being removed from time to time as it collected on the surface. This fat, when dried and filtered, was found to have a sp. gr. of 908·4 at 100° F., being only four-tenths below the highest gravity of the fats obtained directly from the adipose tissue.

The melted horse-fat, at 70° F., formed a clear oil, and the amount of solid fat deposited at lower temperatures was comparatively small.

A series of similar experiments was next made with the adipose tissue of beef, and with portions of the beef from which the whole of the fatty tissue had been removed.

The beef fat was solid in each case at ordinary temperatures, and the melting-points varied from 110° to 116° F., and in these respects it essentially differed from the specimens of horse-fat. From the high melting-points of the beef-fat it was necessary to take the sp. gr. at a temperature of 120° F., and for the purpose of comparison to calculate the theoretical gravity at 100° F. At this temperature the sp. gr. of the beef fat ranged from 903·6 to 904·0, so that there exists a considerable margin between the specific gravities of the two kinds of fat, and this difference affords a positive means of distinguishing horseflesh from beef.

The fact of horse-fat being fluid at a temperature of 70° F. is an important characteristic, and this property alone is almost decisive, in itself, as to the meat being horse-flesh, and is, moreover, a test which could be applied by any intelligent person.

In the case of sausages, where there is a suspicion of their being made with horseflesh, the point may be similarly determined by extracting the fat from the meat, and ascertaining its specific gravity and melting-point.

It may be added that the fat of mutton differs from horse-fat to an even greater degree than that of beef, and that the determination of its specific gravity and melting-point are alike applicable.

The fat of horseflesh, like that of beef and mutton, is free from any of the soluble fatty acids.

As the subject possesses a general interest I shall not allow the question to drop, but intend to pursue the enquiry in its relation to the fat of other animals, and to the determination of the constituent parts of horse-fat.

NOTE ON THE ACTION OF CARBONATE OF POTASH ON SOAP-BUBBLES.

By Dr. LEVOIR.

In experiments in educational physics a very firm froth is obtained when carbonate of potash, at about one-fifth, is present in the soap. For experiments after Plateau on molecular physics it is a good adjunct when fatty matter is to be carefully avoided.

FARADAY'S, BUNSEN'S, AND GIFFARD'S PRINCIPLE IN THE CONSTRUCTION OF LAMPS.

By Dr. LEVOIR.

It gives me pleasure to select this title, firstly, with the object of paying tribute to the science and zeal of these three eminent physicists of the three prominent nations in Europe; secondly, because it affords me the opportunity of directing attention to the basis of the construction of gas-burning lamps of small price but great power.

Faraday demonstrated the usefulness of metallic gauze or texture; Bunsen explained and introduced his tube-lamps among chemists; and Giffard first pointed out the fertile principle in his feed-water injector for transporting fluids and gases by the velocity of effluxion of gases and steam.

In my lamps these three principles are in use together, and when burning make a noise resembling that made by some of the lamps of Mr. Fletcher in Warrington. His form of the outlet for the gas, and the leech-mouth form of Bunsen, is not very practical, because it creates a disturbance in the motion of the air-molecules which have to be mixed with the light gas.

In Bunsen's form of outlet for gas the inflowing air must change its direction perpendicularly, which seriously interferes with the mixing of the effluent gas with the air. I take a conical form, with a very thin and sharp end. By doing this Giffard's principle is used for mixing the coal-gas with the air. Two or more cones are better in large lamps, which can be much lower than the ordinary shape or model. It is understood that the outlet of the gas is a cone from the centre of whose base is bored a cylindrical hole. The edge must be very sharp. In ordinary combustion-furnace lamps for elementary analysis the gas-flames show luminosity because the gas follows one side of the tube, and is only accidentally mixed with the air by outside currents or draughts of air. In that case the gas passes unmixed with air as a ribbon through the tube. If the tube is narrow the friction is so great that a sooty flame results. With a length of 2 inches, a width of 7-16ths of an inch is at least necessary for avoiding the passage of gas without mixture of air. With a slight obstruction in the tube the friction is so great that a kind of filtration occurs where the air is interfered with in its passage to the coal-gas.

Delft (Holland), December 26, 1886.

NICKEL LABORATORY UTENSILS.

By THOMAS T. P. BRUCE WARREN.

Some time ago I had occasion to make an examination of samples of German and English nickel cubes, and also a sample of English grain nickel. I found that the English samples were strongly attracted by the magnet, whilst the German samples were not at all attracted by the same magnet.

The important deduction gained by this result was that certain metals were capable of destroying the magnetic property of nickel.

It is a well-known fact that German silver wire is so far devoid of magnetic influence that it is used extensively for electrical purposes, such as resistance coils. The metal incorporated with nickel when used for this purpose is copper. This alloy is so ductile that there is no difficulty in drawing it into very fine wire; its toughness, when recently drawn, allows of its being covered with silk or cotton, the only precaution necessary being to use no more strain than is necessary to hold the wire taut in the covering machine.

It is a notorious fact that fine wires become in time so brittle that they break by simply being coiled on an ordinary bobbin. In addition to this fact it was found that these wires vary so much in resistance, and were so unreliable for permanency in this respect, that it has been replaced by an alloy of platinum and silver.

It is singular that so visible and important a change in the nickel alloy should have been passed over without some explanation. I have not found wires of thicker gauge—say 16 to 20 B.W.G.—become brittle, and in the finer wires I have noted this brittleness set in after a few months, even when no electrical current has been sent through them.

When my attention was drawn to nickel dishes, crucibles, gauze and wire triangles, which are now easily procured, I obtained a supply from Messrs. Townson and Mercer.

I found no indication of magnetic attraction, and, thinking that pure nickel was neither malleable nor ductile, I thought it would be interesting to find out what metal was alloyed with it which would so modify its physical character.

I found that a very small proportion of tin was present, and a very small quantity of iron, the latter perhaps being simply an accidental impurity. From the fact that the crucibles became lighter in weight by careful heating, arsenic or some volatile metal was suspected of being present; but as my analysis was followed by a negative result, I thought it was not improbable that dissociation at a high temperature would explain the changes taking place.

The wire triangle supports and gauze became brittle and quite rotten after a short time. There was evidently a contraction in the wire used for the triangles. The crucibles were blackened on the outside, but if carefully heated, and simply wiped on cooling, the loss was very slight; but in a smoky flame the crucible exfoliated in a black flaky deposit, and rapidly lost weight. These crucibles, if imbedded in magnesia, do not undergo these changes.

For alkaline fusions these dishes and crucibles are, so far as my experience goes, superior to platinum; but for obtaining water residues where chloride magnesium is present, the residue will be slightly contaminated with the metal, due to the acid which is liberated.

In any operation in which an alkaline or neutral substance can be used, nickel dishes or crucibles are valuable appendages to the laboratory.

That the addition of a para-magnetic metal to a diamagnetic metal should render the same indifferent, magnetically, is easily conceived, and this fact is beginning to receive a value which its importance deserves.

I cannot conclude this article without asking what our own manufacturers are about, as to leave the manufacture of these nickel appliances to our continental friends?

On a future occasion I hope to give the actual analyses of these vessels, and also the analyses of the cubes and grain nickel referred to.

ON THE OCCURRENCE OF SILVER IN VOLCANIC ASH FROM THE ERUPTION OF COTOPAXI OF JULY 22ND and 23RD, 1885.*

By J. W. MALLET, M.D., F.R.S., University of Virginia.

A FEW months ago I received from Señor Julian R. Santos, of Ecuador, formerly a pupil of mine in the laboratory of this University, a specimen of volcanic ash collected at his place of residence, Bahia de Caraguez, on the coast of the Pacific, about 120 miles nearly due west from Cotopaxi. This, the highest and among the most mighty of the active volcanoes of our globe, burst forth into eruption about 11.30 p.m. on the 22nd of July, 1885, and the ash began to fall at Bahia de Caraguez at 7 a.m. on the next day, the 23rd. It fell there to the depth of several inches, this fact alone indicating the discharge of an enormous amount of solid matter into the atmosphere, although Señor Santos wrote to me that the unsettled condition of the country, disturbed by revolutionary movements, prevented his making extended enquiries which might have ascertained the area covered by the fall of ashes.

The specimen sent me consisted of a very finely divided powder, mobile and soft to the touch, of light brownish-grey colour. Under the microscope it appeared to be made up of minute granules and spicules, in general with sharp, more or less splintery edges. These were for the most part colourless and transparent, or white and translucent; some were reddish, some dark bottle-green, some brown, some black and opaque. Most of those clear enough to freely transmit light showed brilliant colours in a field of polarised light. Quartz, two felspars (one white, and one pink or reddish), augite, magnetite (strongly attracted, and easily removed by the end of a magnetic needle), and thin scales of deep red specular iron oxide were easily distinguished.

The ash on being strongly heated before the blowpipe, or even in considerable quantity in a small platinum crucible over the blast-lamp, turned dark red-brown, and fused to a nearly black slag.

On being boiled in its original state with water it gave up 0·21 per cent of soluble matter. The solution gave very distinctly the reactions of chlorine, a sulphate, and sodium; in a less marked degree the reactions of potassium. On boiling with strong hydrochloric acid, 6·94 per cent was dissolved, in addition to that already extracted by water; the acid solution was deeply coloured by iron.

The specific gravity of the ash was found = 2·624 at 18° C. as compared with water at the same temperature.

An analysis of the material taken as a whole, *i.e.*, without any previous mechanical separation of its consistent minerals, and without previous digestion with water or acid, but dried at 100° C., gave the following results:—

SiO_2	56·89
TiO_2	trace
Al_2O_3	19·72
Fe_2O_3	4·06
FeO	3·65
MnO	trace
MgO	1·91
CaO	5·87
Na_2O	5·14
K_2O	1·96
Li_2O	trace
Ag	,,
Cl	,,
SO_4	,,
PO_4	,,
H_2O	0·62
	99·82

Silver was first noticed after fusing as usual with mixed sodium and potassium carbonates, and dissolving in excess of hydrochloric acid, on the addition of sulphuretted hydrogen to the solution, which had been freed from silica; the sulphur thrown down by ferric chloride present was observed to be distinctly brown, and on being filtered out and carefully burned off before the blowpipe it left a minute bead of metallic silver. All the reagents and vessels used were scrupulously examined, but the silver could not be traced to any of them. It was afterwards found that the metal could be obtained from the ash by furnace assay—fusion with pure lead carbonate, sodium carbonate, and a little cream of tartar, and cupellation of the lead button produced; and a comparative experiment was made, with negative result, using larger quantities of the same reagents, but omitting the volcanic ash.

It was ascertained that silver could be extracted from the ash by boiling it with a solution of ammonia, or of potassium cyanide, or of sodium thiosulphate, but the metal was not dissolved out in appreciable amount on boiling with nitric acid. Hence, as seems most probable, it was present in the ash as silver chloride. The fact of its being found in the solution in hydrochloric acid of the mass resulting from fusion with the alkaline carbonates is of course easily explained by the solvent action upon silver chloride of the chlorides of sodium and potassium, and (when such minute quantities are concerned) of hydrochloric acid itself.

The discovery of silver in the ash in question adds for the first time this metal to the list of elementary substances observed in the materials ejected from volcanoes, and the addition derives some special interest from the fact of the ash having come from the greatest of the volcanic vents of the great argentiferous chain of the Andes.

Lead, which was found by Señor Santos himself, when a student here in 1879, in a specimen of ash from the eruption of Cotopaxi of August 23rd, 1878,* was sought for in the ash now reported upon, but neither it nor any other heavy metal beside silver was detectable.

Several concordant experiments proved that the silver was present to the extent of about one part in 83,600 of the ash, or about two-fifths of a troy ounce per ton of 2240 pounds. Small as is this proportion, it must represent a very large quantity of silver ejected during the eruption, in view of the vast masses of volcanic ash which must have been spread over such area as is indicated by the fall at so distant a point as Bahia de Caraguez.

* A Paper read before the Royal Society, Jan. 6, 1887.

On Resorcinic Acetal.—M. Causse.—This compound has the empirical formula $C_{28}H_{14}O_8$, which answers to a mol. of aldehyd and 2 mols. of resorcine less a mol. of water. It forms crystals of a decided yellow colour, which disappears on drying. They are insoluble in water, ether, chloroform, and benzene, but soluble in alcohol, by which it is in part decomposed.—*Journ. de Pharm.*, Oct. 15.

* CHEMICAL NEWS, Oct. 17, 1879 (vol. xl., p. 186.)

A METHOD FOR THE SEPARATION OF SODIUM AND POTASSIUM FROM LITHIUM BY THE ACTION OF AMYL ALCOHOL ON THE CHLORIDES,

WITH SOME REFERENCE TO A SIMILAR SEPARATION OF THE SAME FROM MAGNESIUM AND CALCIUM.

By F. A. GOOCH.

FOR the quantitative separation of lithium from sodium and potassium, Mayer's method,* which is based upon the precipitation of lithium as the tribasic phosphate, and Rammelsberg's† mode of parting the chlorides by means of a mixture of anhydrous alcohol and ether in equal parts, have been available.

The method of Mayer grew out of the older process of Berzelius,‡ which consisted essentially in treating the solution of the alkaline salts with phosphoric acid and sodium carbonate in excess, evaporating to dryness, and extracting with cold water. The result of a single analysis of the product thus obtained was the testimony upon which Berzelius rested the belief and statement that the salt was a double phosphate of lithium and sodium, which left upon ignition sodium and lithium pyrophosphates in equal molecules; and on this Berzelius based his process for the estimation of lithium. Rammelsberg,§ however, showed later that it was a tribasic phosphate which was actually obtained, and from his experiments arrived at the conclusion that the proportion of soda and lithia were variable within wide limits, the amounts of the former varying in the special cases investigated from 7·84 per cent to 28·38 per cent; and the same thing in substance was reiterated subsequently‖ in an account of a repetition of the work suggested by the criticism of Mayer. Mayer,¶ however, was unable to prepare under any conditions the double phosphate of Rammelsberg, and obtained invariably, when the preparation had been washed with sufficient care, trilithium phosphate free from sodium; but the point was made, that the phosphate is apt to be contaminated with lithium carbonate when sodium carbonate is employed to bring about alkalinity. Mayer therefore modifies the method of Berzelius by substituting sodium hydrate for the carbonate; and, proceeding, evaporates to dryness, treats the dry mass with as much water as is needed to dissolve the soluble salts with the aid of heat, adds a drop or two of sodium hydrate if necessary to restore alkalinity, and then ammonia in volume equal to that of the water already added, sets aside at a gentle heat, filters only after twelve hours, and washes with a mixture of ammonia and water in equal parts. From the filtrate and first washings a small amount of the lithium phosphate is to be recovered by evaporation and the repetition of the former treatment. According to Mayer, the precipitation of the phosphate may be effected with equal completeness by boiling the solution, prepared as before, instead of evaporating it; but the objection to this mode of proceeding is the tendency of the liquid carrying the precipitate to bump explosively. Careful washing, somewhat prolonged, is essential to secure the complete removal of salts of sodium and potassium, and it is remarked that the purity of the precipitate is shown by its failure to cake when strongly ignited.

This is the mode of proceeding by which Mayer separates lithium from sodium and potassium, isolating it as presumably pure trilithium phosphate and weighing it as the anhydrous salt. In dealing with mixtures of the chlorides in which the proportion of the lithium salt is relatively small, the removal of the greater part of sodium and potassium chlorides by a preliminary treatment with absolute alcohol is recommended. The following table comprises the results of Mayer's test analyses of lithium carbonate in the first seven, of lithium sulphate in the last two, re-calculated with the use of the number 7—the figure now generally accepted—as the atomic weight of lithium :—

Li_3PO_4 equivalent to Salt taken. Grm.	Li_3PO_4 found. Grm.	Error. Grm.
1·3586	1·3719	0·0133+
1·5172	1·5088	0·0084−
0·7519	0·7580	0·0061+
0·9561	0·9510	0·0051−
1·2651	1·2646	0·0005−
1·2197	1·2230	0·0033+
0·8991	0·9018	0·0027+
1·1325	1·1236	0·0089−
0·9715	0·9665	0·0050−

Fresenius* found on examining the method that several repetitions of the treatment by evaporation and extraction were required to complete the recovery of all lithium phosphate, and advised that the operation be continued until residual lithium phosphate fails to appear. The results of Fresenius's experiments with lithium carbonate, re-calculated with the use of the number 7 as the atomic weight of lithium, are given in the table appended :—

Li_3PO_4 equivalent to Salt taken. Grm.		Li_3PO_4 found. Dried at 100° C. Grm.	Ignited. Grm.	Error. Grm.
0·7443	after two treatments ..	0·7243	—	0·0200−
	after three ..	0·7385	—	0·0058−
	after four ..	0·7433	—	0·0010−
0·9820		0·9861	—	0·0041+
		—	0·9826	0·0006+
1·6341		1·6342	—	0·0001+
		—	1·6305	0·0036−

Thus it will be seen that in the nine experiments of Mayer the error ranges from 0·0133+ grm. to 0·0089− grm., and that of the determinations of Fresenius from 0·0001+ grm. to 0·0041+ grm. for the dried precipitate, and from 0·0006+ grm. to 0·0036− grm. for the ignited precipitate.

If the tendency of lithium carbonate to fall in company with the phosphate were not to assert itself during the evaporations of solutions of salts of lithium in presence of sodium hydrate and in contact with ordinary atmospheric air, it would surely be strange, and this point may be fairly set down as one of the weak ones of the method; but the gravest source of error, and that indicated most unmistakably throughout the whole history of the process,—which has been recounted at some length for the purpose of emphasising this very matter,—is the impossibility of preparing the lithium phosphate in anything like a condition of freedom from other alkaline phosphates without a careful and prolonged washing, which is sure to result in loss of the lithium salt by solution. When it is remembered that according to Mayer's determinations trilithium phosphate requires for solution only 2539 parts of water, or 3920 parts of a mixture of ammonia and water in equal proportions, it is plain that the success of the method depends upon the ability of the analyst to wash to a condition of purity, and without loss of that which it is the purpose of the process to save, a precipitate peculiarly prone to retain foreign matter and soluble in the washing mixture in the proportion of ten milligrms. to every 40 c.m.³ of the latter. Of course washings will never be entirely saturated, nor will the precipitate be as soluble at the beginning of the operation as at the end, when the precipitant no longer exerts an action which tends to lessen solubility; but in view of the difficulties which present themselves, it is sufficiently obvious that exact results obtained by Mayer's

* *Ann. d. Chem. u. Pharm.*, xcviii., 193.
† *Pogg. Ann.*, lxvi., 79.
‡ *Ibid.*, iv., 245.
§ *Loc. cit.*
‖ *Pogg. Ann.*, cii., 443.
¶ *Loc. cit.*

* *Zeit. für. Anal. Chem.*, i., 42.

process owe their apparent accuracy to a fortuitous balance of errors. The difference of 0·0222 grm. between the extremes of Mayer's experimental results should not be surprising; and, at the best, the process is tedious and not entirely trustworthy—facts of which its author was not unmindful.

In Rammelsberg's method of separating lithium chloride from the chlorides of sodium and potassium the sources of error are, in brief, the solubility of sodium chloride and potassium chloride in the ether-alcohol mixture, the influence which the presence of small amounts of water exerts upon the solubility of these same salts, the difficulty of bringing the chlorides to the anhydrous condition without decomposing the lithium chloride to a greater or less extent, and the mechanical difficulties of transferring the fused or crusted chlorides to a suitable receptacle for digestion and agitation in the solvent, and of extracting perfectly the soluble constituents of closely compacted matter. Of the last two items nothing need be said in explanation beyond simply noting them. The third is particularly important, inasmuch as the tendency of lithium chloride, first noted, I believe, by Mayer, to exchange chlorine for oxygen when ignited in presence of water, results in the formation of lithium hydrate or, in contact with products of combustion, lithium carbonate, both of which are insoluble in the mixture of ether and alcohol, and remain with the sodium and potassium chlorides. As to the effect of water in the mixture, an experiment of Mayer, in which it was found that 100 c.m.³ of a mixture of alcohol of 96 per cent and ether of 98 per cent dissolved 0·1100 grm. of sodium chloride, is instructive. In regard to the solubility of the chlorides of sodium and potassium in the mixture of anhydrous ether and alcohol, Rammelsberg's statement, that from 0·9770 grm. of pure strongly-heated sodium chloride with an undetermined amount of lithium chloride the mixture extracted 0·0130 grm., is, unfortunately, meaningless in the absence of information concerning the amount of solvent employed. J. Lawrence Smith* found, in making an examination of this mixture, that 10 c.m.³ of the anhydrous ether-alcohol mixture extracted from 0·5 grm. of sodium chloride 0·0005 grm., and from 0·5 grm. of potassium chloride 0·0003 grm. Smith's mode of applying the method is better than the original; for, by taking care not to heat the mixed salts above 100° C., the danger of decomposing the lithium chloride is diminished, and by treating the dried salts with the ether-alcohol mixture in the capsule in which it is heated and weighed (protecting it by a small inverted bell-glass) the disadvantage of the transfer is avoided, but the danger is incurred that the mixed salts may not be thoroughly dried by heat so gentle. With this modification Smith obtained results which are rearranged in the following statement, and which do not throw a very favourable light upon the method.†

NaCl taken.	KCl taken.	LiCl taken.	Weight dissolved.	Error.
Grm.	Grm.	Grm.	Grm.	Grm.
0·2000	0·2000	0·0080	0·0101	0·0021+
0·2000	0·2000	0·0884	0·0862	0·0022−
0·2000	0·2000	0·8195	0·8341	0·0146+

It is obvious, therefore, that neither the method of Rammelsberg nor that of Mayer may justly claim to be what a good process should be, accurate and rapid; and in the dilemma many chemists have been inclined to accept, with Bunsen,* the inherent disadvantage of an indirect process, and, in a mixture of sodium and lithium chlorides, calculate the percentage of each from the known weight of the mixture and its contents contents in chlorine, and in the mixture of the three chlorides calculate the percentage of each from the known weight of the mixture and the determined contents in chlorine and potassium. Here again, however, as in Rammelsberg's process, the difficulty of bringing the chlorides to a definite condition for weighing without decomposing the lithium chloride is an obstacle; and in case potassium is to be separated from large amounts of lithium by precipitation as potassio-platinic chloride, the concurrent precipitation of a similar salt of lithium, to which Jenzsch† has directed attention, may be the occasion of inexactness. So, the intrinsic unsatisfactoriness of indirect methods quite aside, it appears that in following Bunsen we have by no means all that is to be desired in an analytical method.

In looking about for better means for the separation of lithium from sodium and potassium, certain preliminary experiments on the behaviour of the chlorides of these elements toward amyl alcohol gave very encouraging indications, and subsequent quantitative tests have borne out the hope that a successful method of separation might be based upon these relations.

In amyl alcohol the chlorides of sodium and potassium are highly insoluble, lithium chloride dissolves freely, and the attraction of amyl alcohol for water is so slight and its boiling-point so far above 100° C. that the latter may be expelled without difficulty by the aid of gentle heating.

When amyl alcohol is poured into a solution of lithium chloride in water the liquid forms two layers, the aqueous solution of the salts at the bottom and the amyl alcohol now carrying a little water above. With the application of heat, the water evaporates slowly, then boils, and, passing through the alcohol, escapes, until toward the end of the operation the residual lithium chloride collects in a viscous globule, and finally dissolves, with the exception of a slight incrustation. If now the alcohol is cooled and a drop of strong hydrochloric acid added and brought in contact with the deposit, and the boiling repeated, the solution is complete. This deposit I take to be lithium hydrate, resulting from the decomposition of the chloride by the protracted action of water at a temperature near its boiling-point. The small amount of water which is added in and with the hydrochloric acid seems to exert no unfavourable influence, but rather to be beneficial in hastening the solution of the residue by securing immediate and sufficient contact.

In hot amyl alcohol, lithium chloride appears to be a little more soluble than in the same reagent at ordinary temperatures, but the solubility under the latter condition only was determined. By boiling the solution until turbidity began to show, cooling, filtering, and then evaporating a known volume of the concentrated solution to dryness and weighing the residue after converting it to the sulphate, it was found that one part of lithium chloride was held dissolved in the cold in about fifteen parts of amyl alcohol, 10 c.m.³ of the solution containing in the mean 0·66 grm. of the chloride.

(To be continued).

Determination of Glucose by Means of Standard Solutions.—Dr. Quinquand.—The author modifies Violette's liquid as follows. He takes, Violette's liquid 10 c.c., isinglass 6 centigrms. The liquid is diluted with distilled water to ½ litre, heated to a boil, and let cool. The isinglass is prepared by heating 2½ grm. isinglass in 10 c.c. soap boiler's lye (!) and diluting to ¼ litre with distilled water, 1 c.c. corresponding to 1 centigrm. The liquid is standardised by means of a solution of glucose prepared according to Soxhlet's method.—*Journ. de Pharm.*, Nov. 15.

* *Am. Jour. Sci.* [2], xvi., 56.

† Dr. Smith's language in the description of these experiments is somewhat ambiguous, but it is believed that these figures represent the meaning intended. After the presentation of the data of the first experiment given here with the correction of an obvious typographical error, it is said of the second and third experiments that "a similar mixture containing 18·10 per cent of chloride of lithium furnished a residue of 17·65 per cent," and "a similar mixture containing 67·20 per cent of chloride of lithium gave a residue of 68·40." I have taken this to mean that in all three experiments 0·2 grm. of sodium chloride and 0·2 grm. of potassium chloride were employed with the different proportions of lithium chloride indicated for each experiment. At all events, if this is not the meaning of the language made use of, it is difficult to see a definite value in the experiments.

* *Ann. d. Chem. u. Pharm.*, cxxii., 348.

† *Pogg. Ann.*, civ., 102.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 7.)

THE Secretary then read a paper by Mr. G. L. SPENCER, on

The Kjeldahl Method for the Determination of Nitrogen.

This method for nitrogen determinations has attracted considerable attention since it was announced some three years ago. It is of special interest to agricultural chemists, affording as it does a rapid method for the determination of nitrogen in most of its combinations. It has even been claimed that the nitrogen of nitrates can be determined in this way. The results of a large number of analyses of pure nitrates made in this laboratory indicate that this claim is an extravagant one. This will be discussed further on.

The original method as described by Kjeldahl* has been considerably improved and its application extended by other chemists, notably by Wilfarth,† and later by Asboth.‡ As these modifications are published in detail in the journals referred to, it is not necessary to repeat them here. The following is an outline of the method which I adopted; it is essentially that of Asboth :—

Take from 0·25 to 1 grm. of the substance under examination. Introduce it into a flask (500 c.c.); add 0·5 to 1 grm. anhydrous sulphate of copper, 1 grm. of mercury, and finally 15 c.c. of the following mixture :—

100 grms. sulphuric acid,
50 grms. phosphoric anhydride.

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C., August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

* *Zeit. Anal. Chem.*, 1883, p. 366.
† Wilfarth's method, *Chem. Centralblatt*, 1885, p. 17.
‡ Asboth's method, *Ibid.*, 1886, p. 161.

Nitrogen Determinations by Kjeldahl's Method.

Substance.	Number.	Serial number.	Per cent of N.	Average.	Trescot's results. Soda-lime. Per cent of N.	Soda-lime. Average.	Ruffle. Per cent of N.	Ruffle. Average.
Milk	*a*1	—	0·543	0·543	0·459	0·459	—	—
„	*a*2	—	0·459	0·459	0·465	0·465	—	—
„	*a*3	—	0·448	0·448	0·426	0·426	—	—
„	*b*4	—	0·448	0·448	0·502	0·502	—	—
„	*b*5	—	0·498	0·498	0·409	0·409	—	—
Mustard	*b*6	4511	6·08	—	5·98	—	—	—
„	*c*7	4511	6·38	—	5·98	—	—	—
„	*b*8	4511	6·27	—	5·98	—	—	—
„	*b*9	4511	6·19	—	5·98	—	—	—
„	*b*10	4511	6·33	6·25	5·98	5·98	—	—
„	*d*11	4542	4·20	—	4·05	—	—	—
„	*d*12	4542	4·48	—	4·05	—	—	—
„	*d*13	4542	4·26	—	4·05	—	—	—
„	*d*14	4542	4·26	4·30	4·05	4·05	—	—
„	*e*15	4542	4·83	—	4·05	—	—	—
„	*e*16	4542	4·84	—	4·05	—	—	—
„	*e*17	4542	4·79	4·82	4·05	4·05	—	—
Fertiliser	*d*18	4447	7·73	—	6·77	—	—	—
„	*d*19	4447	7·70	—	6·77	—	—	—
„	*d*20	4447	7·64	—	6·77	—	—	—
„	*d*21	4447	7·78	7·71	6·77	6·77	—	—
Pepper	*e*22	4537	2·10	—	1·79	—	—	—
„	*f*23	4537	2·07	2·09	1·79	1·79	—	—
Cotton-seed meal	*f*24	4194	7·39	—	6·35	—	—	—
„	*f*25	4194	7·36	7·37	6·35	6·35	—	—
Casein	*f*26	—	13·44	—	13·07	—	—	—
„	*f*27	—	13·55	13·49	13·11	13·09	—	—
Gluten	*f*28	—	16·02	—	16·23	—	—	—
„	*f*29	—	15·90	15·96	16·16	16·19	—	—
Fertiliser	*f*30*	4450	1·79	—	1·46	—	1·68	—
„	*f*31	4450	1·79	1·79	1·40	1·43	1·62	1·65
„	*f*32*	4451	2·02	—	1·51	—	2·07	—
„	*f*33	4451	1·96	1·99	1·57	1·54	2·07	2·07
Cotton-seed meal	*f*34*	4452	7·42	—	6·38	—	7·48	—
„	*f*35	4452	7·39	7·40	6·38	6·38	7·48	7·48
Fertiliser	*f*36*	4453	2·35	—	2·02	—	3·42	—
„	*f*37	4453	2·41	2·37	2·05	—	3·58	—
„	*g*38	4453	2·80	—	2·13	—	3·58	—
„	*g*39	4453	2·72	2·76	2·24	—	—	—
„	*h*40	4453	2·41	2·41	2·40	2·17	—	3·53

a One-half grm. $CuSO_4$; the water foamed badly.
b One-half grm. $CuSO_4$; 100 c.c. water + Zn foamed badly.
c As above, except in $CuSO_4$ + Zn.
d One-half grm. $CuSO_4$; 50 c.c. H_2O.
e One-half grm. $CuSO_4$; 50 c.c. H_2O; 1 gr. HgK_2S to precipitate Hg.
f Same as *e*, except + Zn.
g Same as *f*, except + benzoic acid.
h Same as *f*, except + pure sucrose.
* Samples furnished by the Committee.

Heat at a temperature a little below the boiling-point of the mixture. Half an hour is usually long enough to continue the heat. After thorough decomposition the contents of the flask are cooled, 50* c.c. water are added, and the solution is again cooled: 120 c.c. of the following solution are added:—

Rochelle salt	350 grms.
Sodium hydrate	300 ,,
Water	1 litre.

As soon as sufficient sulphide of potassium to precipitate the mercury and a small piece of zinc have been added, the mixture is ready for distillation. Distil over about 50 c.c. into a standard acid solution. Titrate as usual.

I find that the addition of zinc is necessary to prevent bumping. By passing the vapours through a bulb containing broken glass, all liability to error, from portions of the alkali being carried over with the liberated hydrogen, is obviated. I prefer to have the bulb at the end of the tube projecting into the distillation flask. This is essentially the plan recommended by Pfeiffer† and Lehmann. A number of blank experiments demonstrated that there is no error from this source when this device is employed.

The accompanying Table gives a record of the experiments and the results obtained.

An inspection of the table shows that the results obtained were more uniform when mercury was employed.

The following results were obtained with C. P. ammonium salts:—

Substance.	Kjeldahl.	Will and Varrentrapp.	Theoretical.
Ammonium chloride..	26·432	26·210	26·168
	26·430	26·210	26·168
	26·580	26·210	26·168
Ammonium oxalate ..	19·570	19·710	19·718
	20·220	19·710	19·718
	20·220	19·710	19·718
	20·040	—	19·718

I cannot account for the high percentages obtained with these salts. The combustion with soda-lime gives results varying but little from theory.

In his paper‡ Dr. Asboth recommends the addition of benzoic acid to the decomposing mixture when nitrates are present. Kjeldahl does not claim that the method is applicable to nitrates.

I have made a number of experiments by the method as suggested by Dr. Asboth. The results given in the following Table show that with this modification the work was very unsatisfactory:—

Substance.	Kjeldahl.	Ruffle.	Theoretical.
Pure nitrate of sodium, com'l	9·24	—	16·47
	9·21	15·65	16·47
	13·33	16·16	16·47
	13·33	—	16·47
	10·47	—	16·47
	11·20	—	16·47
	10·53	—	13·47
Pure nitrate of potassium ..	13·00	13·55	13·84
	12·94	13·66	13·84
	11·89	14·00	13·84

The unsatisfactory results obtained by the Kjeldahl and Ruffle methods with nitrates led me to experiment upon a method to accurately and quickly determine the nitrogen of nitrates and other forms in the same substance.

Not having had time to make but very few experiments I shall only outline the method and results.

Make an ordinary nitric acid determination by Schulze's method as modified by Tiemans. (See Fresenius, *Quant. Anal.*, p. 473.) Instead of employing ferrous chloride, as directed, I use the sulphate, which answers equally as well and is more convenient.

Transfer the residue from the nitric acid analysis to schälchen and evaporate to dryness, or dry in the flask used for determining the nitric acid. The nitrogen in the residue is determined by the Kjeldahl method. The nitric acid analysis can easily be made in three-quarters of an hour.

A number of experiments made on mixtures of nitrates and cotton-seed meal, gluten, &c., gave nearly theoretical results. It is possible that with very volatile ammonium compounds there might be a loss of ammonia in the nitric acid determination.

At some future time I hope to continue these experiments, and determine the value of this combination of the two methods.

Conclusion.

The results obtained (except with nitrates), and the facility with which analysis can be made, recommended the Kjeldahl method to chemists for a large proportion of nitrogen work usually done in agricultural laboratories.

References. — *Chem. Centralblatt*, 1885, p. 17; *Ibid.*, 1886, p. 161; *Zeit. Anal. Chem.*, 1883, p. 366; *Bulletin Soc. Chemie*, vol. xliv., p. 623; Chemical News, vol. lii., p. 162; *Ibid.*, p. 220; *Chemikerzeitung*, 1885, p. 780; *Chem. Centralblatt*, 1885, p. 585.

(To be continued.)

* 100 c.c. in the original method.

† Bulletin No. 7, Division of Chemistry, U.S. Dept. of Agrl., p. 43.

‡ *Chem. Centralblatt*, 1886, p. 161.

PROCEEDINGS OF SOCIETIES.

RUSSIAN CHEMICAL SOCIETY.

Session October 3/15, 1885.

M. Poehl communicated a new method of determining arsenic, and explained his bacterioscopic researches on the waters of St. Petersburg and its district.

M. Solonina, in continuing his researches on the action of dilute acids upon allylic alcohol, has obtained propylenic glycol in the aqueous portion of the product.

M. Semenoff finds that even in an aqueous solution maleic acid is transformed into fumaric acid if heated to 100°—130°.

M. Latschinoff has isolated from normal ox-gall a monobasic acid analogous to cholic acid, which he proposes to name choleinic acid.

M. Lidoff sent in a paper on the determination of the active chlorine in chloride of lime by a novel method. This method is based on the decomposition of formic acid by calcium hypochlorite.

Session November 7/19, 1885.

M. Poehl made a communication on micro-chemical analysis in chemico-legal cases, and on the photographic reproduction of these microscopic preparations.

M. Rosenblatt sent in a quantitative method for the separation of nickel and cobalt from other metals simultaneously precipitated by ammonium hydrosulphate. Potassium thiocarbonate gives a deep brown solution with the salts of nickel, and with those of cobalt an olive-green solution. In concentrated solutions both nickel and cobalt thiocarbonates are precipitated. These thiocarbonates are not decomposed if heated to 75°, whilst iron, chromium, aluminium, manganese, and zinc thiocarbonates, yield under similar circumstances precipitates of sulphides (iron, manganese, zinc), or of hydroxides (aluminium and chromium). The filtrate is decomposed by acetic acid to precipitate nickel and cobalt sulphides, and these metals are determined electrolytically. For qualitative determination the same liquid containing

nickel and cobalt thiocarbonates is decomposed by hydrogen peroxide.

M. Alexeef sought to explain by a chemical action of glass all the phenomena in which M. D. Konovaloff admits a catalytic action of this body.

M. Rantzoff brought before the Society certain regularities manifested in the atomic weights.

M. P. Schulten sent in a communication on the preparation of magnesium and cadmium oxides in a crystalline state.

M. Wroblewski sent in a note on one of the isomeric xylidines.

M. Werner forwarded a continuation of his thermochemical researches in the aromatic series.

M. Mendeleeff presented remarks on the relations existing between chemical phenomena and phenomena of contact or catalysis.

Session December 5/17, 1885.

Mdlle. Davidoff proved that the ether formed by the action of ethylene bromide upon potassium succinate in presence of absolute alcohol is ethyl succinate.

M. P. Latschinoff has analysed the cholanic and bilianic acids.

M. Werner sent in thermic studies on bromo-substitutions in the aromatic series.

M. A. Sabaneeff discussed the action of sulphuric acid upon oleic acid.

M. V. Pospékoff gave an account of azocumene.

M. D. Konovaloff made a communication with reference to the mechanics of liquids, showing that, setting out from the law of Van der Waals, we may deduce the law of the expansion of liquids, discovered by M. Mendeleeff.

M. Koutcheroff expounded his researches on the metallic carbides of the acetylenic series and the metallo-ammoniacal compounds.

M. D. Mendeleeff communicated his results on the densities of solutions of sulphuric acid.

M. Alexeef gave the continuation of his researches on the vapour tensions of solutions of liquids in liquids.

Session January 9/21, 1886.

M. Kondakoff described products obtained on treating isopropylethylene with dry chlorine.

M. Setchenoff made a communication on the increase of the coefficients of absorption of carbonic acid by saline solutions.

M. Mendeleeff found that the thermic data of Prof. Thompson admit into the solutions $H_2SO_4 . mH_2O$ two of the hydrates deduced from the densities of these solutions.

M. Rantzoff gave a continuation of his deductions on the regularities of the atomic weights of the elements. He sees here a proof of the unity of the matter of which our elements are composed.

M. Mendeleeff opposed this idea.

M. Alexeeff proposed to manufacture cellulose by treating chips of wood with a boiling mixture of sodium sulphite and carbonate. He also replied to the remarks of MM. Menschoutkine and Konovaloff on the catalytic action of glass.

Session February 6/18, 1886.

M. Poehl communicated the continuation of his bacterioscopic researches.

M. Przibytek had succeeded in passing from the dioxide $C_4H_6O_2$ to furfurane and thiophene.

M. Goloubeff made a commmunication on the benzene of naphtha tar.

M. Wroblewsky sent in some remarks on the regularities of the disposition of the halogens and of the groups NO_2 on the substitution of hydrogen in benzene and its homologues.

M. Chechoukoff explained the results of his researches on the action of hydriodic acid upon isobutylene.

M. Sorokine sent in a communication on the anilides of galactose and levulose.

Papers were further handed in on behalf of M. Matoussevitch on the quantity of albumenoid matter in different forage plants; by M. Sivoloboff on the dichlorhydrine of mannite; and of M. Alekhine on melezitose.

M. Schroeder described experiments on supersaturated solutions of sodium hyposulphite. The results appear confirmatory of Nicol's law.

M. Setchenoff continued the account of his researches on the absorption of carbonic acid by saline solutions.

Session March 1/19, 1886.

M. Menschoutkine gave a communication on the constant of rapidity of the action of isobutylic alcohol upon acetic anhydride.

M. Werner sent in an account of researches on the formation-heat of the isomeres in the benzenic series.

M. Konovaloff read a paper on the decomposition of the acetate of tertiary amylic alcohol by acids.

M. Wilson had studied the action of chlorine and bromine upon potassium platinocyanide.

NOTICES OF BOOKS.

Old and New Chemistry: Which is Fittest for Survival? And other Essays in Chemical Philosophy. By S. E. Phillips, F.C.S. London: Wertheimer, Lea, and Co.

The author of this work gives, by way of a Preface, a letter of protest to the Council of the Chemical Society. He had applied, it seems, during November, 1885, for a grant in aid of research, specifying the objects in view as being the analysis of the indium and gallium alums, and the synthesis of uric acid. He had stated in his application that he should be equally well satisfied if the Council would appoint some competent chemist to execute the investigation. That the application was refused appears from the context.

It is further stated that in May, 1886, Mr. Phillips sent in a paper on the "Urethane Reaction," to be read before the Society. This also appears to have been declined. These cases, the author thinks, "tend to justify the authoritative allegation that modern chemists object to free inquiry."

The discussion of the relative merits of "old" and "new" chemistry is given in the form of three essays, entitled respectively "A Brief and Popular Picture of the Chemistry of Fact and Observation," "How the Recent Progress of Knowledge strongly Points in that Direction," and, lastly, "An Appeal to Results." We cannot help asking whether the differences between the so-called "old" and "new" chemistry are not ultimately doomed to fade into insignificance in face of a newer development? Probably neither of them, as we now have it, is fit for ultimate survival.

We next find papers on the urethane reaction, on the aldehyds, ketones, and lactones, and on an outline of the cyanogen compounds.

An appendix treats of "cyanamid genesis," and a second appendix gives a list of unpublished essays on chemical philosophy.

CORRESPONDENCE.

ON THE COMPOSITION OF HYDRATED SALTS.

To the Editor of the Chemical News.

Sir,—We much regret that M. Maumené should have received our remarks on this subject in a spirit of such bitterness; all the more do we regret it because we are not able to withdraw or modify any part of them, in spite

of his glowing panegyric of his own theory to which they are opposed.

Our point is a very simple one, and, if controvertible, can be controverted by experiment only. Most anhydrous salts, even after being subject to the finest powdering and sifted through the finest silk sieve,* and even after drying at 200°, retain a very appreciable amount of enclosed water, and that it therefore is impossible to imagine that hydrated salts, which in very few cases can be sifted so fine, and which can hardly ever be heated or subjected to any previous drying process, should be free from such contained water; that the analysis of a hydrated salt can give no reliable information as to the exact percentage of *combined* water in it.

M. Maumené, it is true, denies that sodium chloride retains any water at 200°, but admits that it does so at 100° ("a few thousandths": according to our determination 0·2 to 0·7 per cent = 0·03 H_2O): even if he be right on this point our argument remains unaffected.

M. Maumené states that, according to his analyses, alum contains 28·73 H_2O, and magnesium sulphate 6·67 H_2O. One of us has made some dozens of analyses of ordinary crystallised alum, and has found the water present to correspond with 24 H_2O, and with magnesium sulphate some scores of analyses gave results corresponding to $7H_2O$ within the second decimal place in the percentage. These salts appear to resemble potassium nitrate in not retaining any enclosed water. Unfortunately we are not, at the present time of writing, within reach of M. Maumené's original work on these salts; but if he relied on the barium sulphate method, or even on a direct estimation of the water as ordinarily performed, it is quite intelligible to us how the error in his results would have arisen (see Pickering, *Chem. Soc. Trans.*, 1885, p. 100; 1886, pp. 16 and 268).

It certainly was not our intention to make any general attack on M. Maumené's theory; but we venture to maintain that, however "beautiful" it be, and however much M. Maumené may bewail the "indifference" of chemists towards it, the majority of us are not prepared to accept his dictum that "all possible compounds in all chemical reactions without exception" are composed of "weights (of elements) which are absolutely equal," and that $KO_{4}{\cdot}875$, $NaO_{2}{\cdot}875$, and $(BaO)_9(HO)_{76{\cdot}5}$ are correct formulæ.

If we might be permitted in all humility to make a suggestion, it would be that whatever truth there may be in M. Maumené's theory would find a readier acceptance amongst English chemists were it not advocated by such arguments as "What it is necessary to prove and explain is that KO forms with HO, $(KO)_9(HO)_{47}$, &c. These truths are proved by the General Theory, because all that results from a general law is proved":—and were it not forced down our throats in what must sound in our insular and prejudiced ears strangely like a *galli cantus* :—

"The Maumené theory is of such universal application that it embraces chemistry in its entirety, without any exception,—lighting it with such clear light that one must be most completely enveloped in the clouds of *routine* not to be enlightened by it."—We are, &c.,

Spencer Pickering.
P. G. Sanford.

Certain Novel Properties of, and on the Analysis of, Gaseous Phosphorus Pentafluoride.—H. Moissan.—The author has decomposed this compound by means of the induction spark, taking care that the gas, the mercury, and the tube are absolutely dry. It is much more stable than the corresponding chlorine compound.—*Comptes Rendus*, Vol. ciii., No. 25.

* It is scarcely necessary to add that that the more coarsely sifted samples were examined as well as the finer ones, in order to ascertain the effect of the size of the particles, and not "to purposely cause mistakes."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ciii., No. 25, December 20, 1886.

Phosphorescence of Alumina.—Edmond Becquerel.—In a memoir recently presented by M. de Boisbaudran to the Academy (vol. ciii., p. 1107) it is asserted that very pure precipitated alumina, when excited by electric discharges in a vacuum, does not give a red light, which, however, can be made to appear by the addition of 1-10,000th oxide of chrome. The author of that memoir deduces from his observations that the characteristic red light is not derived from alumina, but is due to the presence of chrome. M. Becquerel, on repeating the experiment with some of the very same material, obtained an opposite result, in conformity with his former observations. Some fragments of this supposed pure alumina were fixed on a slip of mica with a little gum, placed in the phosphoroscope, and excited by means of the electric arc. They gave an emission of red light, but very feeble and less intense than the light emitted by alumina containing chromium mium oxide, and submitted to the same treatment. But if this pure alumina is ignited for fifteen minutes in a porcelain crucible placed in a gas-furnace fed with compressed air, it becomes as brilliantly luminous and red in the phosphoroscope as alumina containing chrome. In the phosphoroscope we can see bodies only if their luminous emission, after irradiation, has a certain duration measured by the speed of rotation of the discs of the apparatus, but as active bodies may emit, simultaneously, luminous rays, the durations of which are different and shorter than that measured by the rotation of the discs, we can perceive these rays only at the moment when the light acts upon the bodies, that is to say, according to the case, either by means of the ultra-violet light, or, as the author has shown for the first time (see *Annales de Chimie et de Physique*, 3rd series, vol. lv., p. 92), by the aid of electric discharges or effluves in a vacuum. In these latter conditions we have the luminous effects which have been named effects of fluorescence, and which differ from others merely by their duration. Hence the effects presented by bodies excited by these different means are not the same. Further, in case of the effluve the bodies may receive the influence of rays much more refrangible than those furnished by concentrated sunlight, or even by the electric arc, and perhaps these bodies may be also directly excited by the electric discharges themselves. The effluve in a vacuum excites bodies differently according to the degree of exhaustion, and one body may give no effect in an insufficient vacuum, whilst it is brilliant in one more perfect. Conversely another body may be more luminous in the first case than the second, though both are strongly excited in the phosphoroscope. It may happen that the effluve, acting upon mixtures, excites differently each substance contained in the mixture. The effects observed in the phosphoroscope are more simple, but cannot be obtained with all bodies; those observed in a vacuum by means of the effluve are much more complex, but on analysing the light emitted with the spectroscope we may deduce interesting conclusions as to the nature of the substances.

Certain Arrangements for Realising Birefringent Photometers without Polarising the Light.—A. Cornu.—This paper does not admit of useful abstraction.

Wines and Brandies of Raspberries and Strawberries.—Alph. Rommier.—The author recommends the use of the ellipsoidal ferment in the preparation of these wines and liqueurs.

Relations of Efflorescence and Deliquescence of Salts with the Maximum Tension of Saturated Solutions.—H. Lescœur.—The author gives his scales of deliquescence and of efflorescence respectively in the form of tables.

Formation - Heat of Potassium Methylate and Ethylate.—M. de Forcrand.—Not adapted for abstraction.

Journal de Pharmacie et de Chemie.
Fifth Series, Vol. xiv., No. 8, October 15, 1886.

Detection of Peptones in Blood and Urine.—M. Georges.—The author precipitates all the coagulable albumen by means of heat, treats the urine with acetic acid and potassium-mercury iodide, washes the precipitate formed on a filter with cold water charged with acetic acid in the same proportion as is the urine, washes again with the same acid at a boil, and collects the liquid separately. The clear liquid collected deposits a precipitate on cooling if it has dissolved traces of peptonic matter. By neutralising he obtains a solution in which the reaction of biuret may be tried.

Determination of the Dry Extract of Wines.—E. Bouilhon.—Already noticed.

Therapeutic Use of Allyl Tri-bromide.—Armand de Fleury.—A medical paper.

Separation of Strychnine and Morphine from Fatty Matters.—M. Focke.—The suspected matter is exhausted in heat with alcohol acidified with tartaric acid. The liquid when cold is filtered, and evaporated on the water-bath. The residue is taken up with ten times its weight of water, and the solution is mixed with an excess of baryta water. After the lapse of some hours a slight excess of sulphuric acid is added, the mixture is allowed to settle for some time, filtered, and the acid is precipitated with barium chloride. It is filtered afresh, and evaporated on the water-bath until the hydrochloric acid of the barium salt is completely eliminated. The residue is taken up in absolute alcohol, and the solution is evaporated to dryness on the water-bath. The new residue, which is slightly acid, is dissolved in water, and exhausted with ether, which lays hold of fatty matters still contained in the liquid. The aqueous solution is rendered alkaline, again taken up with ether, and, after the evaporation of this solvent, the residue is treated with water acidulated with hydrochloric acid, which dissolves merely the alkaloids.

Reagents for Sugar.—M. Penzoldt.—Already noticed.

Crystalline Aconitine.—J. Williams.—From the *Chemist and Druggist.*

A Reaction of Morphine.—J. Donath.—From the *Journ. f. Prakt. Chem.*

Sensitiveness of Smell.—From the *Pharmaceutical Journal.*

No. 9, November 1, 1886.

Researches on the Sugars.—M. Berthelot.—Already noticed.

The Nutritive Value of Edible Fungi.—Th. Mœrner.—Of the total organic nitrogen present in Fungi a considerable proportion, in some cases 30 per cent, does not exist in a state capable of digestion.

Variations of the Diastatic Action of the Saliva in Different Conditions.—MM. Chittenden and E. Smith.

On Cochineal and the Carmine of Commerce.—C. Liebermann.—Already noticed.

On Naringine.—W. Will.—From the *Bull. de la Soc. Chimique.*

The Fatty or Waxy Matter of Cinchona Barks.—O. Hesse.—From *Liebig's Annalen.*

Wanted, for Germany, an experienced Foreman, practically acquainted with manufacture of Manures, Superphosphate, and Sulphuric Acid on a large scale. Must be accustomed to the supervision and control of workmen.—Apply, in German and English, with full particulars, to R. F., "Colombia," Mülheim am Rhein.

For Sale, quite new, LEAD PUMP, 4 inches diameter, 10 inches stroke, with dermatine bucket and valves, for pumping Sulphuric or other Acids; driving gear, pulleys, wall-brackets, &c., complete. Price low.—Spencer and Co., Lonsdale Chambers, Baldwin Street, Bristol.

The following Books Wanted.—Send Prices and Particulars to JAMES WALSER, Bookseller, 36, Western Road, Hove, Brighton.—"Jacob's Rod," a translation of a French work on the Divining Rod. Ashmole's "Theatrum Chemicum Britannicum." Ashmole's "The Way to Bliss." Raymond Lully's "Paracelsus," translated into English by R. Turner. "L'Abrege des Secrets Chymiques," by P. J. Fabre. Van Helmont's Works, folio, published 1664. "Lexicon Alchemiæ," by Rulando. "Hermetis, Egyptiorum et Chemicorum Sapientia." Helcher's "Dissertatio de Auro." "Hermippus Redivivus." "Lexicon Chymicum," by W. Johnson. "De Alchemia Dialogi Duo."

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of an application by Charles Denton Abel, of 28, Southampton Buildings, Chancery Lane, W.C., for Letters Patent for "Improvements in the production of colouring matters or dyestuffs" (a communication), dated 1st January, 1886, No. 43.

NOTICE IS HEREBY GIVEN that the said Charles Denton Abel has applied for leave to amend the specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and full particulars of the proposed amendment were set forth in the Official Journal of the Patent Office issued on the 8th January, 1887.

Any person intending to oppose the said application must leave particulars of his objections thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date hereof.

Dated this 8th day of January, 1887.

(Signed) H. READER LACK,
Comptroller-General.

ABEL IMRAY,
Agent for the Applicant,
28, Southampton Buildings, London, W.C.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Wet Extraction of Copper.—Can any of your correspondents tell me the best published work in English treating or explaining the process of the wet extraction of copper from Spanish cupreous cinders?—J. N.

Erythrosin.—Can any of your readers inform me by whom and when "erythrosin" (tetra-iodo-fluorescein) was first discovered and described? Any references to original papers or other literature relating to this and other compounds of the eosin series will greatly oblige.—Theta.

MEETINGS FOR THE WEEK.

Monday, 17th.—London Institution, 5.
—— Medical, 8.30.
Tuesday, 18th.—Institution of Civil Engineers 8.
—— Pathological, 8.30.
Wednesday, 19th.—Meteorological, 7. (Anniversary).
—— Society of Arts, 1. "Cameo-Cutting as an Occupation," by J. B. Marsh.
Thursday, 20th.—Royal, 4.30.
—— London Institution, 6.
—— Royal Society Club, 6.30.
—— Chemical, 8. "Some New Silicon Compounds and their Derivatives. I. The Action of Silicon Tetrabromide on Thio-Carbamide," by J. Emerson Reynolds, F.R.S. "Derivatives of Chromo-Organic Acids. I. On Certain Chromoxalates," by Emil A. Werner. "Remarks on Bayer's Paper 'On the Constitution of Benzene,'" by Dr. A. K. Miller.
Friday, 21st.—Royal Institution, 8.
—— Society of Arts, 8. "The Upper Oxus," by Trelawney Saunders.
Saturday, 22nd.—Physical, 3.

THE CHEMICAL NEWS.

Vol. LV. No. 1417.

ON THE CRIMSON LINE OF PHOSPHORESCENT ALUMINA.*

By WILLIAM CROOKES, F.R.S., V.P.C.S.

In a paper which I had the honour of communicating to the Royal Society† in March, 1879, I described the phosphorescence of alumina and its various forms when under the influence of the electrical discharge *in vacuo*, in the following words:—"Next to the diamond, alumina in the form of ruby is perhaps the most strikingly phosphorescent stone I have examined. It glows with a rich full red; and a remarkable feature is that it is of little consequence what degree of colour the earth or stone possesses naturally, the colour of the phosphorescence is nearly the same in all cases; chemically precipitated amorphous alumina, rubies of a pale reddish yellow, and gems of the prized 'pigeon's blood' colour, glowing alike in the vacuum, thus corroborating E. Becquerel's‡ results on the action of light on alumina and its compounds in the phosphoroscope. . . . The appearance of the alumina glow in the spectroscope is remarkable. There is a faint continuous spectrum ending in the red somewhere near the line B; then a black space, and next an intensely brilliant and sharp red line to which nearly the whole of the intensity of the coloured glow is due. . . . This line coincides with the one described by E. Becquerel as being the most brilliant of the lines in the spectrum of the light of alumina, in its various forms, when glowing in the phosphoroscope."

In 1881§ I again returned to the subject, describing a large number of fresh experiments; and I may add that the red glow of alumina has been, off and on, a subject of examination with me since the year first named down to the present time.

In the papers above quoted I gave as accurate measurements of the alumina line as my instrumental means would then permit. I have recently had occasion to go over these measurements again in a large spectroscope of very accurate construction, and the results, I think, are sufficiently important to be worth bringing before the notice of the Royal Society.

The spectrum consists firstly of an exceedingly faint and hazy pair of bands; these are too faint to measure, but they appear to be in about the same position as the bands 1986—2009, and 2031—2075 in the spinel spectrum given further on. Next is seen the characteristic crimson line of the alumina spectrum; this, when examined with a fine slit and high power eyepiece is seen to be double, the distance apart of the components being about half the distance separating the D lines. Then come a pair of fainter and rather nebulous orange lines; beyond them is a dark space followed by a continuous spectrum extending to the green. The following are the measurements of the spectrum:—

Scale of Spectroscope.	λ.	$\frac{1}{\lambda^2}$	Remarks.
10·550°	6942	2075	The first component of the double crimson line.
10·548°	6937	2078	The second component of the double crimson line. These lines are nearly as sharp as the components of D.
10·450°	6707	2223	Approximate centre of a narrow band, shading off at each side.
10·400°	6598	2297	Approximate centre of a narrow band, shading off at each side. This band is somewhat sharper and brighter than the one at 2223.
10·360°	6514	2357	Approximate commencement of the continuous spectrum which extends into the green, shading off too indefinitely to admit of measurement.

The accompanying cut (Fig. 1) gives the spectrum drawn to the $\frac{1}{\lambda^2}$ scale.

It is known that spinel (magnesium aluminate) phosphoresces with a red light, and shows a crimson line in its spectrum.* On examination in the high power spectroscope the spectrum of the light emitted by spinel under the radiant matter test is seen to differ from that emitted by ruby and alumina under the same test, and to closely approximate to the description given by E. Becquerel in 1859.

The spectrum first shows, in the extreme red, a faint double band, then a narrow crimson line, which, however, is not double, like the alumina line, neither is it quite so bright and sharp. Four hazy red bands follow, the fourth being wider and more indistinct than the others. Here the spectrum of most spinels fades away. Sometimes, however, a spinel is seen to glow with a greenish tint; in these the spectrum is the same as the others up to this point, and there is also seen a bright concentration of light in the green.

The measurements of the spinel spectrum are given in the following table:—

Scale of Spectroscope.	λ.	$\frac{1}{\lambda^2}$	Remarks.
10·610°	7096	1986	Approximate commencement of first component of ill-defined double band.
10·595°	7055	2009	Approximate end of ditto.
10·580°	7017	2031	Commencement of ill-defined second component.
10·550°	6942	2075	End of ditto.
10·515°	6857	2127	Centre of sharp crimson line.
10·490°	6798	2164	Approximate commencement of broad hazy band.
10·450°	6707	2223	End of ditto.
10·440°	6683	2239	Commencement of second component of group.
10·405°	6608	2290	End of ditto.
10·400°	6598	2297	Commencement of third component.
10·380°	6555	2327	End of ditto. This band is somewhat sharper and brighter than the other components of this group.
10·370°	6534	2342	Commencement of fourth component of ditto.
10·330°	6454	2401	End of ditto.
9·730°	5541	3257	Approximate commencement of luminous concentration in the green seen in some spinels.
9·440°	5234	3650	Position of maximum luminosity of this concentration of light. From this point the spectrum appears to be continuous, shading off gradually towards the blue and violet.

* A Paper read before the Royal Society, January 13th, 1887.

† *Phil. Trans.*, Part 2, 1879, pp. 660, 661.

‡ *Annales de Chimie et de Physique*, vol. lvii., 1859, p. 50.

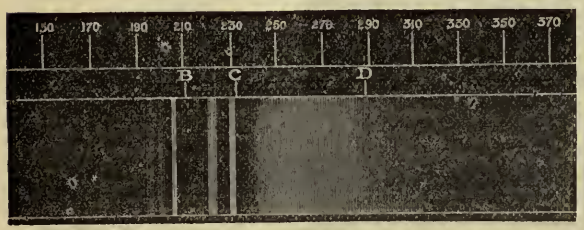
§ *Proc. Roy. Soc.*, vol. xxxii., pp. 206—208.

* E. Becquerel, *Annales de Chimie et de Physique*, vol. lvii., p. 58; W. Crookes, *Proc. Roy. Soc.*, vol. xxxii., p. 208.

The drawing (Fig. 2) shows the spectrum, drawn to the $\frac{1}{\lambda^2}$ scale.

In the *Comptes Rendus* for December 6th last* appears a brief note by M. de Boisbaudran, in which he announces, "*to take date, that alumina, calcined and submitted to the electrical discharge in a vacuum, has not given him a trace of red fluorescence. This fluorescence, as well as its special spectrum, shows itself brilliantly when the alumina contains* 1-100*th and even* 1-1100*th of* Cr_2O_3. *With the* 1-10,000*th part of* Cr_2O_3 *we still obtain very visible rose colour. . . . From these observations the presence of chromium appears to be indispensable to the production of the red fluorescence of alumina.*"

FIG. 1.



The Alumina Spectrum.

This statement being opposed to all my experience, I immediately instituted experiments with a view, if possible, to clear up the mystery. I started with aluminium sulphate, which I knew to be tolerably pure, and in which ordinary tests failed to detect chromium. On ignition and testing in the usual manner in a radiant matter tube, the alumina line was brightly visible in the spectrum of the emitted light. Different portions of this aluminium sulphate were now purified by various processes for the separation of chromium. All gave as a result the absence of this impurity. The most trustworthy process being that devised by Wöhler,† I used it to purify the bulk. The salt was dissolved in water, and excess of caustic potash added till the precipitate first formed re-dissolved. Chlorine was now passed through till no more precipitate fell down and the liquid retained a strong odour of chlorine. The whole of the chromium would now be in solution, whilst the alumina would be in the precipitate. The alumina was filtered off, well washed, and a portion tested in the radiant matter tube. It gave as good an alumina spectrum as did the original sulphate; the crimson line being very prominent.

The alumina thus purified was a second time dissolved in caustic potash and submitted to the chlorine purification. Again in the radiant matter tube the alumina gave its characteristic crimson line spectrum.

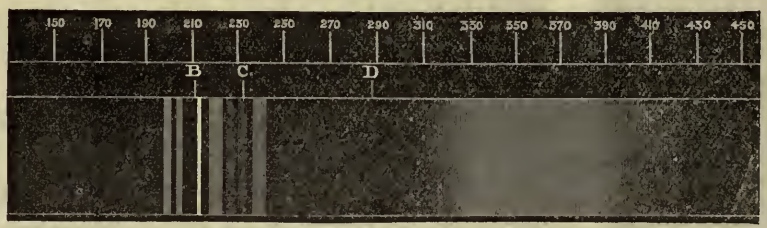
The filtrate from the alumina, which should contain all the chromium present in the form of potassium chromate, was supersaturated with hydrochloric acid and boiled till free from volatile chlorine compounds. Alcohol was then added, and it was again boiled to reduce to the state of sesquichloride of chromium any chromic acid which might be present. Ammonia in excess was now added, and the whole was boiled; a very small precipitate of a brownish colour fell down; it was filtered and washed. This precipitate, which was not more than the 1-50,000th part of the alumina from which it was derived, contained no chromium whatever; it was too small in quantity to admit of a complete analysis being made, but all the tests which I could apply showed it to be a mixture of ferric oxide and alumina.

One part of this precipitate was mixed with 100 parts of the pure alumina from which it had just been separated, and the mixture was tested in the radiant matter tube. The phosphorescence was the same as in the two previous experiments, the crimson line being neither better nor worse.

I now prepared aluminium chromate and tested its action in the radiant matter tube. It was almost black after ignition and refused to phosphoresce. A mixture was then made of aluminium chromate and alumina in the proportion of one part chromium to 100 parts of aluminium. After ignition the colour of the mixture was almost white. Tested, it gave very poor phosphorescence; the alumina line was faintly visible.

Aluminium acetate was mixed with 5 per cent of ammonium bichromate, ignited with sulphuric acid, and tested in the radiant matter tube. There was no phosphorescence. The same mixture was heated to a high temperature before the blowpipe, when it gave a very feeble phosphorescence, but I could detect no line in the spectrum.

FIG. 2.



Spectrum of Spinel (Magnesium Aluminate).

Pure alumina was mixed with 5 per cent of ammonium bichromate and moistened with sulphuric acid. After ignition it phosphoresced with a reddish colour and the spectrum showed a concentration of light in the orange, but no alumina light was visible. The tube was opened and the contents heated to a very high blowpipe temperature. In the radiant matter tube it gave the same results as before.

A mixture of 0·5 per cent ammonium bichromate, 10 per cent of lime, and 89·5 per cent of pure alumina was ignited with sulphuric acid and tested in the usual way. The calcium brought out a trace of yttrium and samarium bands, but no crimson line was to be seen.

Alumina precipitated from its ammoniacal solution by boiling was found to glow with a green light in the vacuum tube and to give no crimson line in its spectrum. The tube was now opened and some of its contents removed and heated in a hot blast blowpipe to the melting-point of platinum for about five minutes. Re-tested in a vacuum tube this alumina was seen to glow at the points and edges of the lumps, where the heat had been fiercest, with a red light, giving a faint line spectrum. The bulk of the mass, however, gave out the original green glow.

To get the crimson line most brilliantly it is necessary to ignite the earth to the highest temperature of the blowpipe

* *Comptes Rendus*, vol. cii., p. 1107.
† "Select Methods in Chemical Analysis," 2nd edition, p. 124.

flame. With a slightly less heat the phosphorescence is not strong and the line is faint. When the temperature has not been raised high enough the colour of the emitted light in most aluminas is green, and no line is visible; whilst the same earth raised to a higher temperature glows with a red light, and the red line comes into view. The most brilliant crimson line, when seen at all, has always been obtained when the alumina has been kept near the melting-point of platinum for some time. Physical differences, or perhaps even difference in molecular composition, also exert a great influence on the phosphorescence of alumina. In this connection I ask permission to quote a sentence from my paper of May, 1881, already mentioned:—"Two earthen crucibles were tightly packed, the one with sulphate of alumina, the other with acetate of alumina. They were then exposed, side by side, to the most intense heat of a wind-furnace—a heat little short of the melting-point of platinum. The resulting aluminas were then tested in the molecular stream. The alumina from the sulphate gave the crimson glow and the spectrum line. The alumina from the acetate gave no red glow or line, but a pale green phosphorescence."

Experience gained in the yttria research has taught me that the possibility of the molecule of aluminium being composed of two or more sub-molecules, only one of which is capable of giving the crimson line phosphorescence, must not be overlooked. To test this hypothesis alumina, as pure as I could prepare it, was submitted to three separate processes of fractionation, the operations in each case being repeated from 20 to 30 times. Alumina giving the crimson line always concentrated towards one end of the fractionations, whilst at the other end the alumina sometimes phosphoresced of a green tint, and at others scarcely phosphoresced at all, the crimson line being either very feeble or entirely absent in the spectrum. The earths were always ignited for the same time and, as nearly as possible, to the same temperature.

In no case could chromium be detected at either extremity of the fractionations.

These experiments are perhaps too few to permit any important inference being drawn from them. There seem, however, to be four possible explanations of the phenomena observed:—

1. The crimson line is due to alumina, but it is capable of being suppressed by an accompanying earth which concentrates towards one end of the fractionations.
2. The crimson line is not due to alumina, but is due to the presence of an accompanying earth concentrating towards the other end of the fractionations.
3. The crimson line belongs to alumina, but its full development requires certain precautions to be observed in the time and intensity of ignition, degree of exhaustion, or its absolute freedom from alkaline and other bodies carried down by precipitated alumina, and difficult to remove by washing; experience not having yet shown which of these precautions are essential to the full development of the crimson line and which are unessential.
4. The earth alumina is a compound molecule, one of its constituent molecules giving the crimson line. According to this hypothesis alumina would be analogous to yttria.

It is not unlikely that a chemist wishing to obtain alumina of exceptional purity might submit it to a series of operations, akin to fractionation, which would have the effect of giving earths phosphorescing either with a strong crimson line, or with little or no crimson line; and either of these samples of alumina might be looked upon by him as pure. It is possible that some such explanation as this may be at the bottom of the contradictory statements respecting the crimson line of alumina.

SOME RECENT RESEARCHES ON THE NATURE OF THE NITROGENOUS ORGANIC MATTER OF SOILS.

By R. WARINGTON.

In the present communication I propose to describe, in the first place, the general results of some very incomplete experiments of my own, made in the Rothamsted Laboratory, and hitherto unpublished; and, in the next place, to call attention to some recently published investigations of considerable importance, bearing on the same subject.

In February, 1883, I made a few experiments to ascertain, if possible, whether amides were present in soil. The soil selected was one rich in nitrogenous matter, having been manured annually with farmyard manure for thirty-eight years. In contained when dry 0·189 per cent of nitrogen. 300 grms. of the dry, finely-powdered soil, were extracted with ammonia-free water on a vacuum filter, after the manner described in *Trans. Chem. Soc.*, 1882, 354. The first extract of 100 c.c. was evaporated to dryness, after being made faintly alkaline with lime-water. The residue left by the watery extract was transferred with a little hot water into Frankland's nitrometer, previously filled with mercury; 5 c.c. of freshly-prepared solution of sodium hypobromite were then introduced. A little gas was evolved in the cold, and more on boiling the aqueous solution with a spirit-lamp. The gas evolved was found to contain 0·000464 grm. of nitrogen. A second watery extract of the same soil gave only a trace of nitrogen when treated in the same manner.*

The residues of a first and second watery extract from the same soil, prepared as above described, but on another occasion, were treated with acetic acid in a flask connected with a Sprengel pump; tubes containing beads moistened with a strong solution of sodium hydrate intervening between the flask and the pump. On the completion of a vacuum, a solution of potassium nitrite, previously contained in a side tube of the flask, was allowed to run in; the gas evolved was collected and analysed. The gas from the first watery extract of 300 grms. of soil contained 0·000719 grm. of nitrogen; the gas from the second extract 0·000343 grm.

There was thus evidence, both from the reaction with hypobromite, and with nitrous acid, of the presence of a very small quantity of soluble amide in the soil.

The soil which had been extracted with water was next treated with 12 grms. of potassium carbonate, and water again passed through the soil, which remained on the vacuum filter. The highly-coloured alkaline extract was re-passed through the soil till the action was apparently completed. The alkaline extract was then shaken with a considerable volume of ether, the ethereal solution being finally separated, and the ether removed by distillation. After treatment with ether, the potassium carbonate solution was acidified with sulphuric acid, and again shaken with ether, the matter dissolved by ether being separated as before. Both quantities of 300 grms. of soil were treated in this way.† The residues of the ether extracts were in one case heated with sodium hypobromite, and in the other case were treated with acetic acid and potassium nitrite, as above described. In no case was any appreciable quantity of nitrogen gas obtained.

It would appear from these results that the potassium

* Sodium hypobromite readily attacks many amides. Asparagine, at a boiling-heat, appears to give up half its nitrogen. If the asparagine has been converted into aspartic acid by heating with hydrochloric acid, and the ammonia formed has been removed by evaporation with an alkali, no nitrogen is produced on heating with hypobromite. When heating a sodium hypobromite solution over mercury, oxygen gas is often evolved, and must be separated before measuring the nitrogen.

† The extraction of the alkaline and acid solutions with ether, as a means of separating basic and acid amides, was suggested to me by Mr. D. A. Louis.

carbonate extract from the soil did not contain amido bases or acids soluble in ether.

The acid solution obtained by adding sulphuric acid to the potassium carbonate extract was submitted to some qualitative tests. Phospho-tungstic acid gave a large precipitate in the solution. This precipitate was proved to contain nitrogen, but no quantitative analysis was made.

G. Loges (*Landw. Versuchs. Stationen*, 1886, xxxii., 201) has stated that the hydrochloric acid extract of soils yields a precipitate with phospho-tungstic acid. He found the ratio of nitrogen to carbon in this precipitate to be about 1 : 6·2 c.c. Further investigation of the subject is promised. Phospho-tungstic acid is a well-known reagent for the precipitation of peptones; its behaviour towards other soluble nitrogenous bodies seems to have been but little studied.

I must next briefly refer to some experiments of my own on the extraction of the nitrogenous matter of soil with hydrochloric acid; these experiments were made between October, 1885, and March, 1886. The soil, and subsoil, of an ordinary arable field was dried and powdered. 400 grms. were shaken during several days with 1000 c.c. of dilute hydrochloric acid. The solution was filtered; ammonia was determined in a part of the solution by distillation with magnesia, and total nitrogen was determined in another portion of the solution by Kjeldahl's method. The hydrochloric extract was for this purpose evaporated to dryness, with a few drops of ferrous chloride (to destroy nitrates), in a glass basin; the residue was heated in a chloride of calcium bath in order to more completely dry it; 10 c.c. of oil of vitriol were then added; the glass basin was then covered with a clock-glass, and heated on a sand-bath to near the boiling-point of the sulphuric acid. When the mass was almost colourless, powdered potassium permanganate was sprinkled in and heating continued for a short time. The whole mass was finally transferred to a large flask, provided with a funnel-tube and exit-tube, the latter connected with the tin worm of a condensing apparatus. Strong soda solution, previously boiled, was introduced through the funnel-tube, the contents of the flask boiled, and the ammonia evolved collected in dilute sulphuric acid. This method was found far more accurate than combustion with soda lime for the purpose of determining small quantities of nitrogen.

The special object of these experiments does not concern us in the present paper. The general result was that the hydrochloric acid removed from the soil considerable amounts of nitrogenous organic matter, the amount increasing with the length of contact, and with the strength of the acid. Both soils and subsoils were in some cases treated four successive times with hydrochloric acid, but in no case was there any appearance of an exhaustion of the nitrogenous matter rendered soluble. All the experiments were made in the cold. The greatest strength of hydrochloric acid employed was 5 per cent by volume of the concentrated liquid acid. No ammonia determinations were made save in the first extract. It will be seen immediately that other investigators have obtained very important results by a more complete study of the action of hydrochloric acid.

Baumann states (*Forschungen auf den Gebiete der Agrikultur-Physik*, 1886, 283) that when soils are boiled for two hours with very dilute hydrochloric acid ammonia is produced, the quantity exceeding by ten or twelve times that pre-existing in the soil.

Berthelot and André (*Compt. Rend.*, Dec. 6, 1886, 1101) have studied the action of hydrochloric acid on soil far more thoroughly. They find that it splits up the insoluble nitrogenous matter, producing ammonia, and soluble nitrogenous matter. The action is greater the greater the strength of the acid, the longer its contact with the soil, and the higher the temperature. The action of a solution containing 20 per cent by volume of the ordinary liquid hydrochloric acid is very considerable. A soil containing 0·174 per cent of nitrogen, boiled for two hours with this acid, gave up 31·8 per cent of its nitrogen; of this amount 7·1 was ammonia, produced by the action of the acid. The proportion of the nitrogen liberated as ammonia, to that remaining in organic combination dissolved by the acid, was about 1 : 3.

From these results, coupled with the well-known production of ammonia when soil is attacked by alkalies, even in the cold, Berthelot and André conclude that the nitrogenous matter of soil consists chiefly of insoluble amides; these by the action of acids, alkalies, or even water, are split up into ammonia and soluble amides. The amides dissolved in the hydrochloric acid they consider to form two classes: (1) those precipitated along with ferric oxide and calcium salts when the acid is neutralised by potash, and (2) those remaining dissolved in the neutralised liquid.

The behaviour of the nitrogenous matter of soil to acids and alkalies is certainly so similar to that exhibited by amides generally, as to render the views of Berthelot and André highly probable. Nor is evidence wanting of the synthesis of amides of the class supposed to exist. The disappearance of ammonia during the fermentation of fresh farmyard manure has been often noticed. Joulie (*Annales Agronomique*, 1884, 297) found that in a mixture of known composition, consisting of finely-divided straw, horse dung, and ammoniacal urine, the large amount of ammonia present at starting steadily diminished, while there was a gradual increase in the organic nitrogen, which was finally 35 to 63 per cent in excess of the amount originally present. We have here, probably, a synthesis of insoluble amides from ammonia and humic acids.

It is, of course, by no means proved as yet that the whole of the organic nitrogen in soils is of an amide nature; for this and other branches of the subject we must await the result of further investigation. The work already done certainly throws much new light on a hitherto obscure subject, and the chief credit of this must be awarded to MM. Berthelot and André.

THE ABSORPTION OF NITRIC OXIDE BY SULPHURIC ACID.

By F. NETTLEFOLD, F.C.S.

THE recent controversy on this subject leaves practical workers much in doubt regarding the correction to apply for this source of error; for it is difficult to understand that no solution of N_2O_2 in H_2SO_4 can take place.

The following results seem to point to the cause of many of the apparent anomalies.

Solutions of Different Samples of Gun-Cotton in H_2SO_4.

0·3 grm. in 7 c.c. H_2SO_4 gave 59·7 c.c. of N_2O_2.
16·7 c.c. added „ 58·4

The 16·7 c.c. „ absorbed 1·3 per c.c. of H_2SO_4, 0·08 c.c. of N_2O_2.

0·3 grm. in 8·3 c.c. H_2SO_4 gave 58·84 c.c. of N_2O_2.
15·7 c.c. added „ 54·94

The 15·7 c.c. „ absorbed 0·90 per c.c. of H_2SO_4, 0·057 c.c. of Na_2O.

0·42 grm. in 16·7 c.c. H_2SO_4 gave 58·4 c.c. of N_2O_2.
10·6 c.c. added „ 57·8

The 10·6 c.c. „ absorbed 0·60 per c.c. of H_2SO_4, 0·057 c.c. of N_2O_2.

Potassic Nitrate Dissolved in Sulphuric Acid.

0·25 grm. air dry in 8·7 c.c. H_2SO_4 gave 53·7 c.c. of N_2O_2.
12 c.c. added „ 51·3

The 12 c.c. „ absorbed 2·4 per c.c. of H_2SO_4, 0·2 of N_2O_2.

0·25 grm. dry in 7·9 c.c. H_2SO_4 gave 58·91 c.c. of N_2O_2.
15·1 c.c. added ,, 57·51

The 15·1 c.c. ,, absorbed 1·4 per c.c. of H_2SO_4, 0·093 N_2O_2.

It will be seen that there is considerable variation in the absorption of nitric oxide by the sulphuric acid, being much less in the case of gun-cotton than in that of potassic nitrate.

Working under precisely similar conditions, results can be obtained corresponding in the first place of decimals, being a most reliable and constant method for nitrogen determinations. But in working in researches where the exact amounts of nitrogen are required, some correction should be made. And it appears that a special correction is required for each substance experimented on.

A sample of pure N_2O_2 was collected over mercury direct into the nitrometer, and H_2SO_4 was added through the funnel stopcock.

With 8·2 c.c. of H_2SO_4, volume of gas .. 41·85
After shaking and standing one hour .. 41·80

So that no absorption seems to take place with the pure gas, though, before shaking, a slight contraction takes place.

The sulphuric acid was sp. gr. 1·842.

The gases measured, at 0° C., 8760 m.m. of mercury.

A METHOD FOR THE SEPARATION OF SODIUM AND POTASSIUM FROM LITHIUM BY THE ACTION OF AMYL ALCOHOL ON THE CHLORIDES,

With some Reference to a Similar Separation of the Same from Magnesium and Calcium.*

By F. A. GOOCH.

(Continued from page 19.)

When aqueous solutions of sodium chloride or potassium chloride are treated with amyl alcohol and boiled, the water disappears, as before, leaving first a globule of the concentrated solution, and finally the crystalline salts. On continuing the boiling until a thermometer, dipped in the liquid, indicates the temperature at which the alcohol boils by itself, a slight additional precipitation, doubtless due to the expulsion of the water retained by the alcohol up to this point, takes place upon the walls of the containing vessel. The results of quantitative tests of the solubility of sodium and potassium chlorides are given in the following tables. The strength of the solutions of sodium chloride and potassium chloride were determined by evaporating weighed portions in a platinum crucible and drying at a temperature considerably below the melting-point of the salt, and weighing. The solution of lithium chloride was standardised by treating a weighed portion with sulphuric acid in excess, evaporating, igniting at red heat, and weighing. The standards were fixed by experiments (1) to (9).

	Weight of Solution of NaCl taken. Grm.	Weight of NaCl found. Grm.	Weight of NaCl in 10 grms. of solution. Grm.	Mean. Grm.
(1)	10·7110	0·1072	0·1001	0·1002
(2)	10·9419	0·1097	0·1003	
(3)	10·9325	0·1097	0·1003	

	Weight of Solution of KCl taken. Grm.	Weight of KCl found. Grm.	Weight of KCl in 10 grms. of solution. Grm.	Mean. Grm.
(4)	9·3045	0·1744	0·1874	0·1872
(5)	10·7225	0·2006	0·1871	
(6)	11·1974	0·2096	0·1872	

	Weight of Solution of LiCl taken. Grm.	Weight of Li_2SO_4 found. Grm.	Weight of LiCl in 10 grms. of Solution. Grm.	Mean. Grm.
(7)	10·9280	0·1635	0·1156	0·1154
(8)	11·1480	0·1665	0·1153	
(9)	10·8790	0·1626	0·1154	

To determine the solubility of sodium chloride and potassium chloride in amyl alcohol, portions of the test solutions were weighed out, evaporated to a convenient bulk in platinum crucibles of 100 c.m.³ capacity, amyl alcohol was added, the water expelled by boiling, and the heating continued for some minutes after the thermometer in the liquid indicated 132° C., the boiling point of the alcohol employed. The liquid was then decanted with care and the residue dried at a temperature below its melting-point, and weighed. When the chlorides are precipitated in the manner described, the deposit generally adheres so closely, and such particles as do remain loose settle so well, that the supernatant liquid may be decanted to the end without appreciable transportation of the insoluble residue. For the sake of perfect security, however, in this part of the manipulation, the decanted liquid was filtered under gentle pressure upon asbestos, with the aid of the device which I have previously described for such purposes,* and, after gentle heating, the increase in weight of the felt and the containing perforated crucible added to the weight of the residual salt. In no case did this increase exceed a few tenths of a milligrm., and often could not be detected.

As a source of heat, a bath in which the sand of the sand-bath is replaced by smooth asbestos board is a convenience, or a piece of asbestos board simply, about 30 c.m. square, supported by a broad tripod and heated under the middle by a Bunsen burner, answers equally well to secure every gradation of heat without danger of igniting the evaporated alcohol.

As a control upon the results obtained by weighing the residue as described, the filtrate was evaporated in a large platinum crucible, and the residue thus left gently heated and weighed. Though the evaporation be conducted with extreme care, the residue is almost sure to show some blackening, due to the carbonisation of matter carried by the alcohol, which will not disappear entirely without the application of a degree of heat which the salts cannot bear without danger of volatilisation. The weight of the residue from the amyl alcohol itself is small,—one portion of 50 c.m.³ yielding 0·0003 grm., and its mate 0 0007 grm. —so that the data obtained by the evaporation of the filtered alcohol of the experiments, if not quite so trustworthy as the former testimony, may nevertheless serve the purpose of a very close control. Both sets of data are given in the following table.

	Weight of NaCl taken. Grm.	Total Weight of NaCl found. Grm.	Weight found in Residue. Grm.	Weight found in Solution. Grm.	Vol. of residual Amyl Alcohol. C.m.³
(10)	0·1062	0·1067	0·1043	0·0024	52
(11)	0·1043	0·1047	0·1024	0·0023	46
(12)	0·1024	0·1030	0·1003	0·0027	51
(13)	0·1003	0·1008	0·0983	0·0025	45

Reducing these figures to a common level to show the action of the same amount of amyl alcohol, in every case we have :—

	Loss of NaCl to 100 c.m.³ of Amyl Alcohol. Grm.	Mean. Grm.	Weight of NaCl found in Solution in 100 c.m.³ of Amyl Alcohol. Grm.	Mean. Grm.
(10)	0·0037	0·0041	0·0046	0·0051
(11)	0·0041		0·0050	
(12)	0·0041		0·0053	
(13)	0·0044		0·0055	

* *Proceedings of the American Academy of Arts and Sciences*, 1886-1887.

* *Proceedings of the American Academy of Arts and Sciences*, vol. xiii., p. 342.

	Weight of KCl taken. Grm.	Total Weight of KCl found. Grm.	Weight found in Residue. Grm.	Weight found in Solution. Grm.	Vol. of residual Amyl Alcohol. C.m.³
(14)	0·2091	0·2093	0·2074	0·0019	35
(15)	0·2074	0·2078	0·2059	0·0019	36
(16)	0·2059	0·2059	0·2040	0·0019	32
(17)	0·2040	0·2041	0·2015	0·0026	45

Derived from these figures we have :—

	Loss of KCl to 100 c.m.³ of Amyl Alcohol. Grm.	Mean. Grm.	Weight of KCl found in Solution in 100 c.m.³ of Amyl Alcohol. Grm.	Mean. Grm.
(14)	0·0049	0·0051	0·0054	0·0056
(15)	0·0041		0·0053	
(16)	0·0059		0·0059	
(17)	0·0056		0·0058	

From these figures it appears that the total weight of chloride found is always a little greater than that taken, the mean increase being 0·0005 grm. for sodium chloride and 0·0002 grm. for potassium chloride. It appears also that the residue left by the evaporation of the decanted and filtered amyl alcohol is greater than the loss put upon the chloride by the treatment—in the case of sodium chloride 0·0005 grm., in the mean, for every 50 c.m.³ of amyl alcohol, which is about the quantity employed in the experiments; for potassic chloride 0·0002 grm., in the mean, for 40 c.m.³ of amyl alcohol, which is approximately the quantity used in that case. It will be seen, therefore, that there exists for both salts an exact coincidence between the mean total excess found and the difference between the figures which indicate the solubility of the salts for the two methods of determination; and, taking this fact in conjunction with the results of the evaporation of amyl alcohol in blank—the mean residue being 0·0004 grm. for 40 c.m.³ and 0·0005 grm. for 50 c.m.³—it seems to be brought out pretty clearly that the former set of figures represents more exactly the solubility of the salts, though the difference between the two series is not great. Resting, then, upon the former determinations, the solubility of sodium chloride may be taken as 0·0041 grm. in every 100 c.m.³ of anhydrous amyl alcohol, or one part in 30,000 parts by weight; and the solubility of potassium chloride, a little greater, is 0·0051 grm. to 100 c.m.³ of amyl alcohol, or one part in 24,000 by weight.

The conditions under which the salts are acted upon are such as should insure the complete saturation of the solvent, and in this connection it is interesting to note that, for the quantities of material employed, the discrepancy between comparable figures never exceeds 0·0005 grm.

In experiments (10), (11), and (14), (15), the alcohol was decanted and filtered at once while hot; in (12), (13), and (16), (17), it was cooled to 30° C. before decanting; so it appears that the solubility of the salts is not influenced by changes of temperature within the range from 'C. to 132° C.

To be continued).

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 21.)

Dr. Gascoyne presented the following Table, giving the results obtained on a variety of fertilising material by the soda-lime method; the method suggested by Professor Johnson, using slaked lime as a substitute for soda-lime; the Ruffle method, and a modification of the Ruffle method, using slaked lime instead of soda-lime, described in full in the report of the nitrogen committee on methods to be used for the determination of nitrogen during the next year. (See Table, next page).

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C., August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

Dr. Gascoyne stated that he had made a number of tests by the modified Ruffle method, using potassium xanthogenate as a substitute for the charcoal and sulphur mixture with good results.

Discussion of the report and papers being in order,

Dr. Jenkins gave it as his experience that the Kjeldahl method gave identical results with the absolute method in the absence of nitrates. Coarse bone, high grade blood, and wheat bran gave results from one to three-tenths per cent higher than with soda-lime. He had also obtained good results with ferro- and ferri-cyanide of potassium, and found that on pure ammonia salts the absolute and Kjeldahl methods agreed. A source of error to be avoided in the latter method was the presence of ammonic sulphate in the sulphuric acid used.

Dr. Chazal considered the committee's samples as an unfair test of the Ruffle method, as they contained nitrate in only one instance.

Professor Lupton said—We have found in my laboratory the Kjeldahl method unreliable in the case of nitrates, but satisfactory in other cases. One great objection to the method is the length of time required for digestion with sulphuric acid. From twelve to fifteen hours were necessary in the case of the samples sent out by the committee.

Dr. Gascoyne then spoke in favour of the use of dry slaked lime and crystallised hyposulphite instead of the committee's mixture; and

Dr. White expressed his approval of the former, using enough sodic hydrate, however, to make the lime more compact and granular.

It was then resolved that, in the absence of Dr. Dabney, the Chair should appoint some one to fill his place to act with the remainder of the committee in preparing recommendations for the ensuing year.

Dr. Gascoyne was appointed.

While awaiting the recommendations of the several committees as to methods to be adopted by the Association, by unanimous consent Mr. de Ghequier was allowed to address the convention.

Mr. de Ghequier said :—

Gentlemen—I have the honour to respectfully submit on behalf of the National Fertiliser Association the request of the committee on legislation, to the effect that you may be pleased to pass before adjourning, a resolution by which, as an association of official chemists, you will indorse the incorporation of such amendment to Senate Bill 372 (H. R. 2933) as will secure the adoption of that method of analysis which you from time to time may decide upon, in all States desiring to obtain the appropriation of 5000 dols. per annum for either agricultural experiment stations or agricultural colleges, and secure likewise one uniform mode of regulation brand, and, above all, uniformity in branding bags, together with an abolition of commercial valuations. Our Association, from its close intercourse with the members of your Association, thoroughly appreciates the sentiments which from time to time have been expressed by you on this very subject, and because it is aware of the fact that your views coincide fully on this matter with those entertained by the trade, the committee on legislation indulges in the hope that the request now preferred to put your opinions in a tangible form on record so as to enable us to urge on solid grounds the passage of such amendments as will procure for the trade the possibility to have for one brand only one bag will meet with a favourable reception. The multiplication of State laws increases yearly the number of bags a manufacturer has to keep on hand, and exposes him uselessly to lawsuits and losses without any benefit whatsoever accruing from this variety of expressions to the farmer. On the contrary, the views of the vast majority of the members of your Association clearly indicate that you not only recognise the justice of our desire to see an absurdity replaced by a provision more in accord with the dictates of common sense, but are disposed to assist us in this direction. The opportunity to do so in an efficient

	Soda-lime.		Slaked lime.		Ruffle method.		Ruffle method modified.	
	Per ct.	Average.	Per ct.	Average.	Per ct.	Average.	Per ct.	Avge.
Ammoniated superphosphate ..	1·67		1·64		1·63		1·66	
	1·69— 1·68		1·68— 1·66		1·69— 1·66		1·70— 1·68	
„ „	1·94		1·97		1·97		1·97	
	1·98— 1·96		1·99— 1·98		2·03— 2·00		2·01— 1·99	
Bone meal..	4·10		4·07		4·13		4·15	
	4·14— 4·12		4·11— 4·09		4·17— 4·15		4·15— 4·15	
Cotton-seed meal	7·35		7·30		7·40		7·38	
	7·39— 7·37		7·36— 7·33		7·46— 7·43		7·42— 7·40	
Dried blood	12·23		12·27		12·31		12·33	
	12·31—12·27		12·31—12·29		12·39—12·35		12·41—12·37	
Azotin	12·98		12·98		13·03		13·05	
	13·04—13·01		13·02—13·00		13·09—13·06		13·11—13·08	
Fish scrap..	8·12		8·13		8·14		8·12	
	8·18— 8·15		8·17— 8·15		8·22— 8·18		8·18— 8·15	
Castor pomace..	4·98		4·98		5·00		5·00	
	5·04— 5·02		5·02— 5·00		5·04— 5·02		5·06— 5·03	
Peruvian guano	7·46		7·45		7·51		7·50	
	7·50— 7·48		7·49— 7·47		7·55— 7·53		7·56— 7·53	
Ammoniated superphosphate with 1 p.c. of nitrogen from nitrate ..					4·30		4·32	
					4·36— 4·33		4·40— 4·36	
Ditto ditto ..					6·44		6·44	
					6·52— 6·48		6·48— 6·46	
Ground tobacco stems					1·54		1·50	
					1·58— 1·56		1·54— 1·52	
Commercial nitrate of soda.. ..					15·90		15·91	
					15·96—15·93		15·99—15·95	

way now presents itself, and hence the request of our Association for the passage of a resolution indorsing Senator Chace's amendment.

Nearly 10,000,000 bags are consumed by the trade, and some firms use upwards of 300,000. For four brands four bags would suffice; at present, however, it is necessary to keep a stock at least sixty to a hundred on hand. It is a hardship the greatness of which no one can properly realise except those who during the rush of a shipping season witness the trouble and annoyance which is daily incurred on that ground.

The very science—agricultural chemistry—which has called the fertiliser industry into being should certainly not be the means of throwing superfluous obstacles in the way of the prosecution of that business, and the time has arrived, it seems to me, when to the signal services rendered by agricultural chemistry to the trade in a scientific way proper assistance in a business way should be granted by removing what you yourselves admit to be entirely useless obstructions. As regards commercial valuations, it will ever remain an impossible attempt to impress upon the farmer that they represent only a means of comparing prices, but do not represent either the agricultural value of fertilisers or the figure at which a manufacturer should sell his goods. It is carrying the paternal government theory too far, and experience has shown that no good has thereby been accomplished. If the farmer is incompetent to judge from the analysis what is and what is not a good article, why is his ignorance not in a similar way assisted in the many other articles which he is bound to purchase. Flour, agricultural implements, boots and shoes, prints, &c., might, with precisely the same justice, and on precisely the same ground, have commercial valuations attached, and I think it would be quite a surprise to farmer and scientist to see what an enormous margin of profit there is in nearly every commodity and how comparatively insignificant the same margin is on fertilisers. Commercial valuations can hardly be said to be more than a discrimination against the very industry which has done more to build up a greater productiveness of the soil than all others put together. On this point, however, there has so much been said that it is quite familiar to you that I forego to dwell upon this subject.

Our Association is in hearty accord with the bill appropriating 5000 dols. per annum to each State, because it believes that these additional funds will enable the Control Stations to increase their usefulness, and lighten, by the employment of an increased force, the labour which at certain seasons renders the chemist's work in the laboratory a very heavy and trying burden.

The publication of the method of analysis in all the minutiæ of detail goes far towards reducing differences, as it enables the chemists employed by the manufacturers to conform to it, as that the official analyses ought to be only confirmations of those previously obtained by the manufacturer. I am sure the trade will think the millennium has arrived if the discrepancies are once reduced to three-tenths of 1 per cent, and from the results laid before this meeting by the several committees it would seem as if that day is near at hand.

Permit me in conclusion to thank you for the interest you take in, and the unpaid labour you bestow upon, those investigations which in the end tend to benefit not only science but the fertiliser industry likewise, and to tender you also, on behalf of the committee on legislation and of the Association, their grateful appreciation of the consideration you accord to our representatives and requests.

In reply Professors Stubbs and Lupton spoke strongly against the Association taking part in any national legislation. They were willing to do everything possible with their State legislatures, but could not feel justified in sanctioning national interference in the matter.

After some further remarks from other members of the Association, on motion of Dr. Jenkins the communication of Mr. de Ghequier was referred to the Committee on Uniformity in Legislation.

The Committee on Revision of the Constitution, with a view to enlarging the field of the Association, was then asked to report, and submitted the following, which was unanimously adopted:—

The committee appointed to revise the constitution, in

accordance with the suggestions referred to it, recommends the following changes:—

Section 1 to read:

(1) This Association shall be known as the Association of Official Agricultural Chemists of the United States. The objects shall be (1) to secure uniformity and accuracy in the methods, results, and modes of statements of analysis of fertilisers, soils, cattle foods, dairy products, and other materials connected with agricultural industry; (2) to afford opportunity for the discussion of matters of interest to agricultural chemists.

Section 2 to read:

(2) Analytical chemists connected with departments of agriculture, agricultural experiment stations, agricultural colleges, State boards of agriculture, and other bodies charged with official control of the materials named in Section 1, shall alone be eligible to membership, and one such representative for each of these institutions or boards when properly accredited shall be entitled to a vote in the Association. Only such chemists as are connected with institutions exercising official fertiliser control shall vote on questions involving methods of analysing fertilisers. Any person eligible to membership may become a member at any meeting of the Association by presenting proper credentials and signing this constitution. All analytical chemists and others interested in the objects of the Association may attend its meetings and take part in its discussions, but shall have no vote in the Association.

Section 4 to read:

Strike out the word "three" in first line. Insert after "Committee on Nitrogen" the following:—"The committee on cattle foods and the committee on dairy products, whose reports shall be taken up, discussed, and disposed of in the order named. Additional committees may be appointed from time to time as the Association may direct.

Section 7 to read:

Seven enrolled members, entitled to vote, shall constitute a quorum for the transaction of business, instead of a "majority shall constitute a quorum."

Section 9 to be added:

All proposed alterations or amendments to this constitution shall be referred to a select committee of three at a regular meeting, and after report from such committee may be adopted by a vote of two-thirds of the members present and entitled to vote.

The remaining portions of the constitution, as now printed, to be retained unchanged.

Respectfully submitted,

H. C. WHITE, Chairman.
E. H. JENKINS.
WM. MCMURTRIE.

Dr. WHITE reported as follows:—

The Committee on Phosphoric Acid has carefully considered the several suggestions referred to it, and respectfully recommends the following as the detailed method to be employed for the next year:—

Method of Determining Phosphoric Acid in Fertilisers.

(1) *Preparation of Sample.*—The sample should be well intermixed and properly prepared, so that separate portions shall accurately represent the substance under examination without loss or gain of moisture.

(2) *Determination of Moisture.*—(*a*) In potash salts, nitrate of soda, and sulphate of ammonia, heat 1 to 5 grms. at 130° C. till the weight is constant, and reckon water from the loss. (*b*) In all other fertilisers, heat 2 grms., or if the sample is too coarse to secure uniform lots of 2 grms. each, 5 grms. for five hours at 100° in a steam bath.

(3) *Water-soluble Phosphoric Acid.*—Bring 2 grms. on a filter; add a little water; let it run out before adding more water, and repeat this treatment cautiously until no phosphate is likely to precipitate in the filter. If the washings show turbidity after passing the filter, clear up with acid. When the substance is nearly washed in this manner, it is transferred to a mortar and rubbed with a rubber-tipped pestle to a homogeneous paste (but not further pulverised), then returned to the filter and washed with water until the filtrate measures not less than 250 c.c.; mix the washings. Take an aliquot (usually corresponding to $\frac{1}{5}$ or $\frac{1}{2}$ grm. of the substance), and determine phosphoric acid as under total phosphoric acid.

(4) *Citrate-insoluble Phosphoric Acid.*—Wash the residue of the treatment with water, into 150 c.c. flask with 100 c.c. of strictly neutral ammonium citrate solution of 1·09 density; shred and add the filter-paper; cork the flask securely; place in a water-bath with constant temperature of 65° C., and digest for thirty minutes at this temperature with frequent shaking. Filter the warm solution quickly, and wash with water of ordinary temperature.

Transfer the filter and its contents to a capsule. Ignite until the organic matter is destroyed; treat with 10—15 c.c. of concentrated hydrochloric acid; digest over a low flame until the phosphate is dissolved; dilute to 200 c.c.; mix; pass through a dry filter; take an aliquot and determine phosphoric acid as under total.

In case a determination of citrate-insoluble phosphoric acid is required in non-acidulated goods, it is to be made by treating 2 grms. of the phosphatic material without previous washing with water, precisely in the way above described, except that in case the substance contains much animal matter (bone, fish, &c.) the residue insoluble in ammonium citrate is to be digested with HCl and $KClO_3$ as described below.

(5) *Total Phosphoric Acid.*—Weigh 2 grms. into a flask or beaker; add 30 c.c. concentrated hydrochloric acid; heat and add cautiously and in small quantities at a time, about 0·5 grm. finely-powdered potassium chlorate. Digest at a gentle heat until all phosphates are dissolved and all organic matter destroyed; dilute to 200 c.c.; mix; pass through a dry filter; take 50 c.c. of filtrate; neutralise with ammonia; add about 15 grms. dry ammonium nitrate, and to the hot solution, for every decigrm. of P_2O_5 that is present, 50 c.c. of molybdic solution. Digest at about 65° C. for one hour; filter and wash with ammonium nitrate solution. (Test the filtrate by renewed digestion and addition of more molybdic solution.)

Dissolve the precipitate on the filter with ammonia and hot water, and wash into a beaker to a bulk of not more than 100 c.c. Nearly neutralise with hydrochloric acid; cool, and add magnesia mixture from a burette, slowly (one drop per second), stirring vigorously. After fifteen minutes add 30 c.c. of ammonia solution of density 0·95. Let stand several hours (two hours is usually enough). Filter; wash with dilute ammonia; ignite intensely for ten minutes and weigh.

(5) *Citrate-soluble Phosphoric Acid.*—The sum of the water-soluble and citrate-insoluble subtracted from the total gives the citrate-soluble.

Preparation of Reagents.

(1) *To prepare Ammonium Citrate Solution.*—Mix 370 grms. of commercial citric acid with 1500 c.c. of water; nearly neutralise with crushed commercial carbonate of ammonia; heat to expel the carbonic acid: cool; add ammonia until exactly neutral (testing by saturated alcoholic solution of coralline), and bring to volume of 2 litres. Test the gravity (which should be 1·09 at 20°) before using.

(2) *To prepare Molybdic Solution.*—Dissolve 100 grms. of molybdic acid in 400 grms., or 417 c.c., of ammonia of sp. gr. 0·96, and pour the solution thus obtained into 1500 grms., or 1250 c.c., of nitric acid of sp. gr. 1·20. Keep the mixture in a warm place for several days, or until a portion heated to 40° C. deposits no yellow precipitate of ammonium phospho-molybdate. Decant the solution from any sediment, and preserve in glass-stoppered vessels.

(3) *To prepare Ammonium Nitrate Solution.*—Dissolve

200 grms. of commercial ammonium nitrate in water, and bring to a volume of 2 litres.

(4) *To prepare Magnesia Mixture.*—Dissolve 22 grms. of recently ignited calcined magnesia in dilute hydrochloric acid, avoiding excess of the latter. Add a little calcined magnesia in excess, and boil a few minutes to precipitate iron, alumina, and phosphoric acid; filter; add 280 grms. of ammonium chloride, 700 c.c. of ammonia of sp. gr. 0·96, and water enough to make the volume of 2 litres. Instead of the solution of 22 grms. of calcined magnesia, 110 grms. of crystallised magnesium chloride ($MgCl_2.6H_2O$) may be used.

(5) *Dilute Ammonia for Washing.*—One vol. ammonia of sp. gr. 0·96 mixed with 3 volumes of water, or, usually, 1 volume of concentrated ammonia with 6 volumes of water.

Respectfully submitted.

H. C. White, Chairman.
E. H. Jenkins,
W. C. Stubbs.

On motion of Prof. Lupton this was made the official method for the ensuing year.

(To be continued.)

NOTICES OF BOOKS.

On the Comparative Value of Nitrogen and Ammonia Salts. By Thos. Brown. 1886.

The author of this paper, which was read at the Chemical Manure Manufacturers' Association, has been experimenting on various fertilisers for some years, and now brings forward the results of some of his experiments, hoping they may prove interesting and useful. Twenty years ago Mr. Brown first tried ammonium sulphate as a corn manure in Norfolk, the expense being less than that of sodium nitrate, which had been used very successfully, but the farmers who used it reported unfavourably; in this case it was used as a top dressing, but after it had been properly covered by the soil very satisfactory results were obtained, better even than those obtained with sodium nitrate.

In the spring of 1880 Mr. Brown again tried ammonium sulphate as a top dressing, but was surprised and disappointed at not finding any advantage from its use. His conclusions were:—1st, that ammonium sulphate has much less value than sodium nitrate when used as a top dressing; but, 2nd, it is a very useful manure when sown early with spring corn. In some experiments with root crops the results have generally been in favour of the ammonium sulphate. In 1873 18 tons 17 cwt. of swedes were obtained with 1¼ cwt of sulphate per acre, and 17 tons 15 cwt. with 2 cwt. of nitrate per acre, the ammoniacal salt having an advantage of 1 ton 2 cwt. In 1875 the results were again in favour of the sulphate. Every year it is noticed that the sulphate and superphosphate plot gives a slight increase; by the addition of potash, however, the yield of the nitrate is brought slightly above that of the sulphate plot.

Other experiments were made with various soils to ascertain which one had more tendency to lose nitrogen than another. The samples were all placed in shallow boxes and ammonium sulphate sprinkled on the surface and raked in. The surface was damped every day and the boxes exposed to free air, but protected from the sun. After standing for twelve days the nitrogen was estimated and was found to have decreased in every case, in quantities varying from 23·3 per cent to 61·2 per cent of that added as ammoniacal salt. The greatest loss occurred in soils containing a high percentage of chalk.

The results recorded in this paper are of undoubted interest, and should point out to farmers the unadvisability of using costly manures containing nitrogen without consulting an expert who could advise them as to what was most suited to any particular kind of soil.

Thomson's Conspectus, adapted to the British Pharmacopœia of 1885. Edited by Nestor Tirard, M D., F.R.C.P. New Edition. London: Longmans, Green, and Co.

This work opens with an Introduction giving a general description of the classes of bodies mentioned in the Pharmacopœia. Then follows the Conspectus strictly speaking, the various drugs and compounds being arranged in alphabetical order, with mention under each of its source (if needful), its composition, chemical and physical properties, action on the human system, its uses, doses, tests for its presence or for possible impurities, the substances with which it is incompatible, and an enumeration of the official preparations in which it occurs.

In the first item we note an oversight. Gum acacia is said to be composed of carbon, hydrogen, oxygen, *nitrogen*, and calcium. Nitrogen certainly does not enter into its composition.

The Appendix contains notices of some of the more important non-official medicines and preparations.

Then follows a chapter on poisons. Here we miss some old acquaintances, such as aniline, nitrobenzol, and the soluble compounds of chromium. The author says indeed:—"Many poisonous substances are purposely not noticed, because they are not likely to be employed as such, and consequently they do not demand general attention." Now the three substances just mentioned are not very likely to be used by a would-be suicide, nor yet to be intentionally administered by a poisoner. But they are all now prepared on the large scale, and they may be accidentally introduced into the system by various channels. The vapours of aniline and nitrobenzol, and the dust of the alkaline chromates, may be inhaled. Hence it is, we would submit, desirable that medical men, in the manufacturing districts at least, should be able to refresh their memories concerning the symptoms occasioned by these bodies and the treatment to be adopted.

In the directions for detecting cantharides the author lays some weight on the "green shining particles" found in matter extracted by means of the stomach-pump, or found, on a post-mortem examination, adhering to the coats of the intestine. These particles when found are decisive, but there are several other kindred insects (such as *Cantharis vittata*) met with in commerce which possess the same properties, and may be used for the same purposes, but which have not this colour.

The test here recommended for the detection of poisonous fungi, *viz*, applying a piece of silver to the cut surface, is not fully trustworthy.

A third Appendix deals with the art of prescribing; a fourth states the proportions of the more active ingredients contained in pharmacopœial proportions; a fifth gives the atomic weights of the elementary bodies mentioned in the Pharmacopœia; a sixth gives a comparison of weights and measures; whilst a seventh gives the composition of the chief mineral waters, referred in some cases to a gallon, in others to 1000 grains, but in the majority of instances to a quantity of 7680 grains.

Concerning the utility of this little book there can be no doubt, and we hope that the trifling flaws which we have been compelled to point out may be eliminated in the next edition.

CORRESPONDENCE.

ON THE COMPOSITION OF HYDRATED SALTS.

To the Editor of the Chemical News.

Sir,—Messrs. S. Pickering and P. G. Sanford say, in their last letter, "Our point is a very simple one, and, if controvertible, can be controverted by experiment only." I join issue with them on this ground, and I ask—

1st. Have Messrs. S. Pickering and P. G. Sanford taken the trouble to prepare their alum from *pure* Al_2O_3 and KO? No, since they say "of ordinary crystallised alum"; *ordinary*, that is not *pure* as everybody knows.

2nd. Have these gentlemen designed to dry their *ordinary* alum according to my method, by means of a large mass of thoroughly desiccated alum? No; they dried it in the ordinary manner with sulphuric acid, and have taken no notice whatever of my last note, in which I stated that, when under the desiccator, alum loses water continuously for 167 days without *ever* remaining in the condition corresponding to 24 HO.*

3rd. Can these gentlemen deny the existence of $SO_3MgO=60$ united with 60 of water, that is 6·67 HO? Let them dry this salt with a large mass of the same salt deprived of nearly all its water, and they will obtain *equal weights*.

4th. Let them have the kindness to try the same experiment with CaCl, and they will find $CaCl=55·5$ united with 55·5 of water, that is 6·17 HO.

5th. May I ask my two honourable *confrères* to give a little attention to my theory? If they will, they will find that the "equal weights," which is the starting point of it, will soon become as familiar to them as the origin of the weights 5 : 3—3 : 1, &c., and they will not be long in recognising the application of these consequences to the whole science of chemistry *without any exception*. — I am, &c.,

E. Maumené.

Paris, January 15, 1887.

CHROMIC ACID COMBUSTION OF GLYCERIN.

To the Editor of the Chemical News.

Sir,—I see in Chemical News, vol. lv., p. 2, that Messrs. Cross and Bevan state, in a short note, that they intend to apply the chromic acid combustion method to the analysis of carbon compounds. If they will turn to Chemical News, vol. liii., p. 271, they will see that I then applied chromic acid in the determination of carbon in waters, and checked the results by testing the method of combustion thus applied by means of known weights of pure cane-sugar, and obtained almost absolutely the theoretical amount of carbon in the sugar. Messrs. Cross and Bevan, therefore, have been anticipated by me, and, in fact, I began to use this method of combustion in August, 1884.

On the 7th of December, 1886, I read a paper before the Manchester Literary and Philosophical Society, further developing this method in the analysis of waters. I there pointed out how to determine the carbon, 1st, by the method given in my first paper; 2nd, by boiling with a solution of chromic acid of known strength and titrating the chromic acid still remaining unreduced by the carbon and hydrogen, by means of a standard ferrous sulphate solution, using a weak solution of potassium ferricyanide as an indicator.

I further pointed out that on boiling waters with chromic acid and sulphuric acid, the nitrogenous matter is *entirely* converted into ammonia, and this remains in the apparatus as ammonium sulphate. On distilling this off with pure caustic soda solution into a cylinder the distillate contains all the nitrogen (present in the water) as ammonia, and its amount is determined either by Nessler's reagent or in some other way.

I checked these analyses by testing the action of chromic acid on strychnine, obtaining fairly good results so far as the carbon and nitrogen were concerned. In the discussion which arose I pointed out the convenience of the method in *the ultimate analysis of organic compounds*, and reserved to myself the working out of the method, as then stated, for the determination of carbon, hydrogen, nitrogen, &c., in organic compounds of all kinds. I reserve that right now. My paper was really a preliminary note, and is not yet out of the printer's hands.

I intend to test my method of volumetric analysis of organic compounds thoroughly, and also ascertain how far chromic acid will be of service in the determination of nitrogen in manures, soils, foods, waters, and all kinds of organic compounds.—I am, &c.,

Charles A. Burghardt.

The Owens College, Manchester,
Jan. 11, 1887.

* Pure alum, octahedric or cubic, remains quite transparent with 28·73 HO; but when it is put under a shade with sulphuric acid, in two hours time it shows opaque spots, the number of which increases incessantly, and, I repeat it, without stopping, to 26, 25, 24, ... 7, 6, 5, HO, &c.

HEATING APPARATUS.

To the Editor of the Chemical News.

Sir,—I have received from Prof. Dunnington, of the University of Virginia, a communication enclosing a description of a heating apparatus published by him in the *American Chemical Journal* for 1882. This apparatus, though it is not, in its details, adapted for the work for which the apparatus described in Chemical News, vol. liv., p. 302, was designed, yet embodies all its essential characters. I had not seen the paper he refers me to, and indeed the outward arrangement of the two forms of the apparatus differs so much that, had I done so, I should probably have overlooked the resemblance between them. With your permission I therefore gladly take the first opportunity to acknowledge the priority of Prof. Dunnington, and to thank him for his courtesy in drawing my attention to his paper.—I am, &c.,

G. H. Bailey.

The Owens College, Manchester,
Jan. 14, 1887.

NICKEL LABORATORY UTENSILS.

To the Editor of the Chemical News.

Sir,—Like Mr. Blount, I have not been very fortunate in my use of nickel vessels, and as my experience has been in a different line from his it may be useful to give the results of it.

Tempted by the low price of these vessels, I procured two small dishes for milk analysis and used them several times. However, though they were never ignited (being used only for total solids and fat), they *lost weight every time*, the average loss being, for one vessel 2·8 m.grms., and for the other 3·1 m.grms., or a total loss of 0·051 grm. and 0·056 grm. respectively, after being used eighteen times each.

The loss, however, was not uniform, and as it amounted to 6 and 8 m.grms. on two occasions after use with buttermilk, I concluded it was due to the action of lactic acid.

To test this I weighed one of the dishes and evaporated a very dilute solution of the acid in it on the water-bath. As the result I found that the drop of strong acid left behind was coloured green, and that the dish had lost 6·5 m.grms in weight.

Thus, it is not safe to use these vessels for milk analysis unless the weight is checked before each determination. —I am, &c.,

Thomas Farrington, M.A., F.C.S.,
Analyst to the County Cork Agricultural Society.

Analytical Laboratory, 4, Waterloo Place,
Cork, Jan. 11, 1887.

Detection of Salicylic Acid in Foods.—H. Taffe. —The author agitates the suspected sample with a mixture of equal parts of ethylic ether and of petroleum ether. The salicylic acid is thus dissolved out even when in very small quantities.—*Bull. de la Soc. Chim. de Paris*, vol. xlvi., No. 12.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
3rd Series. Vol. xvi., November, 1886.

A Presidential Address delivered before the Chemical Section of the British Association.—W. Crookes, F.R.S.—From the Chemical News.

On the Methods of Chemical Fractionation.—W. Crookes, F.R.S.—From the Chemical News.

The Fractionation of Yttria.—W. Crookes, F.R.S.—From the Chemical News.

Studies on Melitose or Raffinose extracted from Treacle, Cotton-Seed, and from the Eucalyptus-Manna.—B. Tollens and P. Rischbiet.—From *Liebig's Annalen*, and already noticed.

Sanitary Value of the Chemical Analysis of Potable Waters.—Dr. W. G. Tucker.—From the Chemical News.

Arificial Production of Codeine.—From the *Pharmaceutical Journal.*

Optical Method for the Analysis of Quinine Sulphate.—D. Hooper, F.C.S.—From the *Pharmaceutical Journal.*

Poassium and Sodium Peroxides: A Lecture Experiment.—H. Carrington Bolton.—From the Chemical News.

Method for Determining the ill-tasting Oil in Alcohol, especially in Brandy and Liqueurs.—Dr. J. Traube.—From the Chemical News.

December, 1886.

Petroleum and its Products (conclusion). — Mr. Boverton Redwood.—From the *Journal of the Society of Arts.*

Study of the Theory of Turkey-Red Dyeing.—P. Lukianoff.—Alizarine oils consist of two matters, the one sort soluble in water and the other insoluble. The soluble matter has a very distinct acid character, whilst the insoluble portion contains no sulphur, and contains glycerides. The author has sought to determine what part is played respectively by the soluble and the insoluble matter in the formation of the red lake. To determine this point he took five swatches of cotton and prepared them, one with the soluble portion alone, another with the insoluble portion alone, and the remaining three with mixtures of the two in different proportions. The swatches after oiling were submitted to the usual treatments and lastly dried and brightened. The swatch oiled with the soluble portion alone afforded the purest and reddest tone, but it was relatively the least full and level. The swatch prepared with the insoluble portion alone was the fullest in colour and the most even, but its tone was impure and yellowish. The other swatches presented intermediate degrees of brightness and of saturation, according to the proportions of the two ingredients used. The swatches oiled with the insoluble portion were the best able to resist the action of boiling soap-lyes and of chlorine.

Chrome Mordants in Dyeing Logwood Blacks on Wool.—J. B. Wilkinson.—From the *Journal of the Society of Dyers and Colourists.*

Industrial Review and Patents:—

Obtaining metallic copper, zinc, lead, and silver, and lead peroxide by the electrolysis of their fluosilicates or fluoborates.—G. Leuchs.

Electrolytic treatment of lead and argentiferous copper ores.—E. Marchese.

Process for separating and re-collecting the fatty acids carried away by residual water.—C. E. Schroers.

Improvement in the separation and purification of the grease of suint and of its combination with water to form a waxy substance known as lanoline.—Fabrik Chemischer Producte, Berlin.

Purification of the grease of suint.—W. Graff.

Preparation of neutral and supersaturated soaps by adding to ordinary soaps ammonium sulpholeate, or sulpholeic acid.—Dr. W. Kirchmann.

Assay of Various Primary Materials used in Dyeing and Printing.—Brief directions for examining samples of alizarine, starch, sodium bichromate, cake-alum, red liquor, glycerin, and antimonial mordants. (*Dingler's Journal*).

On Soaps.—C. R. Alder Wright and C. Thompson.—From the *Journal Soc. Chem. Indust.*

Chrome Mordants in Dyeing.—Emile Blondel.—The author reviews the various methods which have been proposed for fixing chrome upon the vegetable fibre. He describes the alkaline chrome mordant of Kœchlin as modified by himself, the basic nitrate and a double chromium calcium, or chromium magnesium nitrate. The latter serves well for fixing sumac, bark, catechu, berries, gallocyanine, anthracene blue, cœruleine, &c. On oiled tissues the shades obtained are more intense.

Industrial Society of Mulhouse.—Session of the Chemical Committee, Oct. 13, 1886.—M. Grosheintz sent in a paper on a thermometer for measuring the mean temperature of a hot flue and transmitting its indications direct to the furnace-room.

A sealed paper deposited by M. Rud. Geigy (Nov. 12, 1885) was opened at his request. It contained the following process for a blue dye for cottons. If we diazotise a mol. of diamido-diphenetol and pour the solution of the diazo-derivative into the solution of 2 mols. of α-naphthol sulphonic acid (prepared with diazo-naphthionic acid) we obtain a blue colouring matter which dyes cotton a blue without mordant either in an acid or an alkaline bath. The colour bears acids and soaping.

M. Noelting presented a memoir on the azimido-derivatives.

Determination of Indigo on Textile Fibres.—Adolphe Renard.—The author takes 10 grm. of the dyed material, introduces them into a flask with 200 c.c. of a solution of neutral sodium hydrosulphite mixed with milk of lime. The solution is prepared by adding 2 litres water and 100 c.c. milk of lime to 100 c.c. of neutral sodium hydrosulphite prepared with sodium bisulphite at 35° B. The mixture is heated to 60—70° in the water-bath, when the fibres are decolourised, and, as well as the liquid, take a yellowish colour. A current of coal-gas is then passed into the flask, which is agitated until every trace of blue colour has disappeared; the liquid is then quickly decanted into a graduated jar, still continuing the current of gas. When cold, he measures the volume of the liquid and precipitates with hydrochloric acid, and after settling for twelve hours he receives the deposit of indigotine upon a small filter. It is washed, dried, dissolved in 10 c.c. of fuming sulphuric acid, and determined by Müller's method.

Use of Ammonium Citrate in the Analysis of Precipitated Phosphate.—H. Shepherd.—From the Chemical News.

Determination of Mixtures of Milk and Cane-Sugar.—Stokes and Bodmer.—From the Chemical News.

Determination of Milk-Sugar in Milk.—Creydt and Tollens.—From the Chemical News.

Use of Acetic Acid in the Analysis of Milk.—Johnstone.—From the Chemical News.

MISCELLANEOUS.

Normal School of Science and Royal School of Mines.—We are requested to state that the number of applications for admission to the Normal School of Science and Royal School of Mines, at South Kensington, at the commencement of the present Session, having been considerably in excess of the accommodation which the School can afford, it has become necessary to adopt some process of selection for the future. Hereafter, application for admission should be sent to the Registrar of the School before the end of May, accompanied by a statement of the studies which the applicant has already pursued, the examinations he has passed, and the name of a teacher (or teachers) to whom reference may be made. Such applications will be considered by the Dean and Council of the School, who will decide on them according to their merits. A knowledge of Elementary Mathematics, such as is required of all Royal Exhibitioners and National Scholars, will be held to be of the first importance for those who desire admission to the Course for the Associateship of the School; while for occasional students, who propose only to take up certain specific branches of Science, some preliminary knowledge of them will have weight.

Chemistry of the Alkaloids and Albumenoids.—We are requested to announce that Prof. Armstrong's Course of twenty lectures on the Chemistry of Nitrogen and its Compounds, with special reference to the recent investigations of the Alkaloids, Albumenoids, &c., to be delivered at the City and Guilds of London Institute, Central Institution, Exhibition Road, S.W., on Mondays and Wednesdays, at 5 p.m., will commence on Monday, January 24th, and not on the 27th as advertised in some papers. The following notes are extracted from the Syllabus of the Course:—"Inasmuch as nitrogen compounds are essential constituents of all animal and vegetable structures, and as the characteristic properties of the nitrogenous compounds are, it is to be supposed, largely conditioned by the presence of nitrogen as dominant element, the study of the chemistry of nitrogen is of the highest importance. To mention but a few cases:—It is of importance in relation to the question of the comparative values of *different food-stuffs*, and in relation to the use of *nitrogenous manures*. It is of importance in relation to the phenomena of *fermentation*, and therefore to the *brewing* industry. It is of importance in relation to the putrefactive changes induced by the *disease-producing bacteria*, and also to the physiological and medicinal effects produced by alkaloids. It is of importance in relation to the *tanning, wool and silk dyeing industries*, as the raw materials dealt with are nitrogenous compounds. In the lectures the endeavour will be made first to clearly bring out and illustrate the characteristics of the element nitrogen by reference to the properties of its simpler compounds. Subsequently an account will be given of the methods adopted in investigating the alkaloids, albumenoids, &c., and of the state of our knowledge of the more important nitrogen compounds. Whenever possible experimental illustrations will be given of the operations and methods described.

AMONGST the most recent applications of the Æolus Waterspray system of heating, cooling, and ventilating, are the Conservative Club, Birmingham; Castle Street Schools, Bristol; Heath Town Chapel, Wolverhampton; Four Courts, Dublin; Mission Hall, Brondesbury; St. Peter's Church, Jarrow-on-Tyne; Parish School Room, York; Mr. Mendelssohn's Studios, Cathcart Road, South Kensington; large theatre of the Polytechnic, Regent Street; The London and Provincial Turkish Bath Co., 76, Jermyn Street; St. Mary's Schools, Gibbet Street, Halifax; H.M. Prison, Bodmin; offices of the Rio Tinto Co. (fourth installation); All Saints Church, Highgate; Congregational Church, Rectory Road, Stoke Newington; Western Daily Press Office, Bristol (second installation),

MEETINGS FOR THE WEEK.

MONDAY, 24th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "The Diseases of Plants," by Dr. Thudichum.
TUESDAY, 25th.—Institution of Civil Engineers 8.
—— Royal Medical and Chirurgical, 8.30.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8 "The Volcanic Eruption in New Zealand," by J. H. Kerry Nicholls, F.R.G.S.
WEDNESDAY, 26th.—Geological, 8.
—— Society of Arts, 8. "Photographic Lenses," by J. Traill Taylor.
THURSDAY, 27th.—Royal, 4.30.
—— London Institution, 6.
—— Telegraph Engineers, 8.
—— Royal Institution, 3. "Molecular Forces," by Prof. A. W. Rücker, F.R.S.
FRIDAY, 29th.—Royal Institution, 9. "The Lineal Eye in Lizards," by W. Baldwin Spencer, M.A.
—— Quekett Club, 8.
SATURDAY 29th.—Royal Institution, 3. "Modern Composers of Classical Song—Robert Franz," by Carl Armbruster.

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THE CHEMICAL NEWS.

Vol. LV. No. 1418.

THE DETECTION OF ADULTERATION OF METALLIC NICKEL AND OTHER METALS BY THE MAGNET.

By THOMAS T. P. BRUCE WARREN.

During the winter of 1881-2, whilst lecturing to a class at the Silvertown Institution, on Electricity and Magnetism, I was desirous of showing to the students the magnetic property of metallic nickel. Through the kindness of Matthew Gray, Esq., at that time President of the Institution, I borrowed from the India-rubber, Gutta-percha, and Telegraph Co., Silvertown, a specimen of nickel cubes, which consisted in fact of two samples received some time before from Germany. The difference in price of the two samples was so little that they were thrown together into a drawer, as it was thought at the time that there could not be much difference between them with respect to purity, &c.

A handful of these cubes was placed on the table, and, on bringing an ordinary compound horse-shoe magnet near the cubes, I was very much surprised to find that, whilst some of these cubes were forcibly attracted by the magnet, others were not affected at all, or so slightly that they could not be supported by the magnet against their own gravity. Some cubes were attracted slightly when placed very near to the magnet, but could not be lifted.

I thought the matter of sufficient interest that I entrusted the chemical examination of these samples to one of the students in the Laboratory of the Institution.

I afterwards examined the whole of the nickel contained in the drawer with the magnet in the same way, and in two or three minutes I had the samples sorted out into their original lots of 2 kilogrammes each.

The magnet readily picked out the better quality at the rate of twenty or thirty cubes at a time, until what was left could not be drawn out by the magnet. To make sure of the result, the "magnetically selected" cubes were again tested with the magnet, when it was found that a few non-magnetic cubes had been drawn up by entanglement with the others. By the second operation the separation was perfect.

There was no very marked difference in these cubes which would lead one to suspect anything worth noting. A closer examination showed that the non-magnetic cubes were a trifle whiter and presented the absence of a striated structure, which was well defined, though unequally, with the magnetic cubes.

This method of examination was extended to samples of English grain nickel, and also to portions of anodes of English, American, and German manufacture.

It may be sufficient to remark here that the grain nickel was powerfully attracted, and that the anodes, although drawn up by the magnet, were not so strongly attracted as the grain or magnetic cubes.

The fact that nickel has become an article of commercial importance, and that chemical analysis has disclosed the fact that this metal is liable to extensive adulteration, which can be so easily detected by the magnet, led me to believe that this subject deserved a more extended examination.

Special examinations of these cubes were made for lead, bismuth, antimony, cobalt, and sulphur, which were decidedly absent, although traces of some of these were detected in the anodes.

The following gives the percentage of composition of the cubes referred to;—

	Magnetic.	Non-magnetic.
Copper	0·083	33·779
Carbon	0·071	0·365
Silica	0·409	0·160
Iron	2·457	0·841
Arsenic	0·117	0·865
Tin	0·749	0·461
Nickel	96·670	63·690
	100·556	100·161

The oxide of nickel obtained from the non-magnetic sample was reduced by heating in a current of hydrogen: this reduced metal was then even more magnetic than the other sample. A portion was placed in a test-tube, which was inserted between the poles of a powerful horse-shoe magnet; it readily took up an axial position, which was not disturbed on carefully rotating the tube.

Portions of this metal were alloyed with small quantities of tin, arsenic, and antimony separately, which had a decided effect on its magnetic property.

Cobalt in its pure state behaves like nickel, and when alloyed with paramagnetic metals is similarly affected.

I have extended the examination more recently to nickel crucibles and dishes, and also to the wire triangles before and after heating, all of which are magnetic both before and after heating.

I have frequently noticed that the loss on one of these crucibles, when strongly heated over a Bunsen burner, is very slight compared with the bulky accumulation of black deposit which is produced. A few days ago I collected considerably over a gramme of this powder, which on analysis consisted almost entirely of graphitoidal carbon, with minute quantities of nickel, iron, and silica.

I may mention that a platinum crucible heated in the same flame remained quite bright: the curious deduction arising from this is, that these vessels are capable of actually decomposing the gas in a Bunsen's flame. A precaution which should therefore be taken is *not* to use these supports for platinum crucibles.

This unlooked-for result led me to use hydrogen as a means of heating these nickel crucibles, taking care, of course, that the intense heat was not allowed to act injuriously on them. If coal-gas be used, the flame must not be allowed to impinge upon the crucible.

I have now some experiments in hand with a view of ascertaining their behaviour in a muffle furnace heated with ordinary gas, as alkaline fusions for the analysis of earthy minerals are frequently required in practice.

So far as my experiments have gone the crucible gains in weight, due to oxidation when heated in a muffle, but there is this difference—that the oxide formed is strongly adherent to the crucible, and is not rubbed off by the fingers, in the hydrogen flame: oxidation does not take place on heating, but the precaution is necessary, to allow the cooling to go on in a current of this gas in order to avoid oxidation.

I find that there is a difference in the composition of the nickel gauze and wire supports, and the crucibles and dishes. Malleability, so far as my analyses go, is produced by the addition of iron and manganese.

The composition of the malleable alloy from which the dishes and crucibles are made will be given in my next paper on this subject.

I may just state that commercial manganese and some other metals which are generally classified as magnetic are met with, in which magnetic attraction is notoriously absent. This deserves attention, as in the construction of magnets other metals are added to iron to increase its retentive power when hardened, and it is by no means improbable that the polarity of soft iron may be modified as regards its residual magnetism by the addition of other metals of the same or opposite series.

NICKEL CRUCIBLES.

By JOHN H. J. DAGGER, F.I.C.

Having, for the past fifteen months, used nickel crucibles in my laboratory, a few notes on my own experience with them may be of interest.

At first I found that unless care was taken to keep the metal from contact with the reducing zone of the flame the crucible became covered with black flakes which, on cooling, scaled off, seriously affecting the weight of the crucible.

I then made the following experiments.

A clean polished lid was weighed and then heated over an ordinary Bunsen flame turned down and screened from all draughts, the lid so being exposed to the upper point of the reducing zone of a small flame. After heating for an hour it was allowed to cool. On examination the lid was blackened and corroded in form of a small ring at the point where the flame impinged on the metal.

On weighing—

(1)	Weight of lid before ignition ..	8·9310 grms.
	„ „ after „ ..	8·9385
	Gain	0·0075

The burner was then turned to a full flame so that the entire surface of the lid was exposed to the reducing zone. At the end of an hour a comparatively large amount of deposit had formed on the lid.

On weighing—

(2)	Weight of lid before ignition ..	8·9385 grms.
	„ „ after „ ..	9·0030
	Gain..	0·0645

After cleaning and comparing with original weight of lid—

	Grms.
Weight of clean polished lid before ignition..	8·9310
After two ignitions	8·9250
Loss on original lid	0·0060

The black deposit was then transferred to a weighed porcelain crucible and heated to redness with access of air till weight remained constant.

Weight of residue.. ..	0·0525 grms.
After ignition..	0·0090
Loss	0·0435

The ignited residue was of a brownish grey colour and contained nickel, the loss being apparently carbon.

A second lid was then weighed and heated over the oxidising zone of a Fletcher Argand Bunsen, so that the whole surface became heated. At the end of an hour the under surface of the lid was slightly blackened, the upper being covered with a brownish film.

On weighing—

(1)	Weight before ignition ..	7·9570 grms.
	„ after „ ..	7·9610
	Gain.	0·0040

On re-heating for another hour and weighing—

(2)	Weight before ignition ..	7·9610 grms.
	„ after „ ..	7·9630
	Gain	0·0020

On lowering this lid into the reducing zone it became coated with the black deposit.

It follows from these experiments that nickel crucibles can be used if exposed to the oxidising zone only.

In course of an analysis a quantity of the mixed oxides of Sn and Sb were fused with caustic soda in a weighed crucible over a Fletcher Argand flame for twenty minutes. The crucible was afterwards cleaned and re-weighed.

Before fusion . ..	18·6165 grms.
After „	18·6145
Loss ..	0·0020

Fusion with nitre corroded the metal, giving a rough grey surface. The nitre showed traces of nickel.

I find that for fusions with alkalies at low red heat, and for evaporations of alkaline solutions, the crucibles are very satisfactory; at higher temperatures, small quantities of nickel pass into the fused matter.

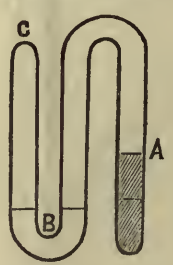
A nickel crucible, if carefully used, will last about sixty fusions; after that it begins to develop cracks. Nickel wire triangles I find to be unsatisfactory; after heating several times they become brittle and break suddenly.

3, West Bank Road, Edge Lane,
Liverpool, Jan. 14, 1887.

ON THE DECOMPOSITION OF AMMONIUM CHLORIDE BY MEANS OF AN ALLOY OF ZINC AND IRON.

By H. N. WARREN, R.A., A.I.C.

Two grms. of finely-powdered zinc eisen (consisting of zinc alloyed with 12 per cent of iron) were intimately mixed with 4 grms. of pure dried ammonium chloride, and introduced into a pressure-tube constructed as in Fig. 1. In the limb A is introduced ammonium chloride mixed with the zinc compound, and in the bend B a small quantity of mercury, the point C being afterwards closed by means of the blowpipe. The limb A is maintained at a constant temperature by means of a chloride of zinc



bath. The reaction having terminated, the tube was allowed to cool, and the point C being first immersed under the surface of water was quickly broken, the mercury rushing out with great violence in consequence of a large quantity of compressed hydrogen contained in the tube, due to secondary actions, &c. The mercury in coming in contact with the water immediately swelled up to several times its original bulk, giving off large quantities of ammonia gas, and in every respect resembling the well-known ammonium amalgam; and shortly regaining its original size and fluidity. On experimenting a second time, using instead of mercury a fluid amalgam of tin and mercury, the amalgam was considerably more stable, even when under the surface of water. A third experiment was performed, substituting for the zinc pure lime, but on introducing the mercury into water no swelling of the mercury was observed. It would thus appear that the zinc compound in the first place frees from the ammonium chloride its ammonium, H_4N, the zinc combining with the chlorine according to the following equation, $2H_4NCl + Zn = ZnCl_2 + 2H_4N$; but the ammonium being an unstable compound or body, and not being able to exist at the ordinary normal pressure, is at once resolved into ammonia and hydrogen gas, as is the case when the above-mentioned experiments are not performed

under pressure; the reaction at the commencement in both cases being evidently identical, but in the latter case being confined and the pressure gradually becoming more intense, it exerts, as it were, an influence over the atoms to connect themselves somewhat more closely together, thus giving greater stability to the ammonium and at the same time inducing it to amalgamate with the mercury. In performing these experiments I may mention that great care is required by the experimenter, and in the method of constructing the pressure-tube, since a malformed tube may result in a serious explosion.

ANALYSES OF COMMERCIAL FERTILISERS.

(Continued from p. 33.)

DR. GASCOYNE, from the Committee on Potash, then recommended the following method for determining potash:—

Method for Determining Potash.

In case the potash is contained in organic compounds like tobacco stems, cotton-seed, hulls, &c., it is to be saturated with strong sulphuric acid and ignited in a muffle to destroy organic matter. Pulverise the fertiliser (200 or 300 grms.) in a mortar; take 10 grms., boil for ten minutes with 200 c.c. water, and after cooling and without filtering, make up to 1000 c.c. and filter through a dry paper. If the sample have 10—15 per cent K_2O (kainite), take 50 c.c. of the filtrate; if from 2—3 per cent K_2O (ordinary potash fertilisers), take 100 c.c. of the filtrate. In each case make the volume up to 150 c.c., heat to 100°, and add, drop by drop, with constant stirring, slight excess of barium chloride; without filtering, in the same manner add barium hydrate in slight excess. Heat, filter, and wash until precipitate is free of chlorides. Add to filtrate 1 c.c. strong ammonium hydrate, and then a saturated solution of ammonium carbonate until excess of barium is precipitated. Heat. Add now in fine powder 0·5 grm. pure oxalic acid or 0·75 grm. ammonium oxalate. Filter, wash free of chlorides, evaporate filtrate to dryness in a platinum dish, and, holding dish with crucible tongs, ignite carefully over the free flame below red heat until all volatile matter is driven off.

The residue is now digested with hot water, filtered through a small filter, and washed with successive small portions of water until the filtrate amounts to 30 c.c. or more. To this filtrate, after adding two drops of strong hydrochloric acid, is added, in a porcelain dish 5—10 c.c. of a solution of 10 grms. of platinic chloride in 100 c.c. of water. The mixture is now evaporated on the water-bath to a thick syrup, or further, treated with strong alcohol, washed by decantation, collected in a Gooch crucible or other form of filter, washed with strong alcohol, afterwards with 5 c.c. of ether, dried for thirty minutes at 100° and weighed.

It is recommended that if there is an appearance of white foreign matter in the double salt it should be washed with 10 c.c. of a half-concentrated solution of NH_4Cl which has been saturated by shaking with K_2PtCl_6, rejecting the first portion running through and using 10 c.c. of fresh solution, returning the latter portion five or six times upon the salt and finally using another portion, and then alcohol and ether, after the method recommended by Gladding.

As an alternative the entire method of Lindo, as modified by Gladding, may be used in the determination of potash when, in the opinion of the analyst, it is found satisfactory.

The use of the factor 0·33056 for converting K_2PtCl_6 to KCl and 0·19308 for converting K_2O are continued.

Respectfully submitted,

W. J. GASCOYNE, Chairman.
CLIFFORD RICHARDSON.
M. A. SCOVELL.

On the motion of Dr. WHITE the recommendations were adopted as the official method for the ensuing year.

Dr. GASCOYNE then presented the report of the Committee on Nitrogen, embracing recommendations for the use of the Ruffle method.

Professor STUBBS desired to know if, were this report adopted, the Ruffle method alone would be official, and this being apparently the case, he dissented from its adoption.

Dr. JENKINS said that he felt that he could not give up the Kjeldahl and absolute method, but that were the Ruffle adopted as official he should check his results by that.

Considerable opposition to the adoption of any one method being apparent, it was moved and passed—

That no single method be selected as official, but that the Association recognise as such either the Ruffle, Kjeldahl, absolute, or soda-lime methods, when carried out according to working details to be supplied by the committee.

These details are presented in the Appendix.

Miscellaneous business being in order, the Committee on a Uniform Law presented the following report:—

The committee appointed at the last annual session "to consider the question of uniformity of legislation and regulations as to the inspection of fertilisers, and to prepare a draft of uniform law," and to whom the communication of the National Fertiliser Association presented through Mr. de Ghequier has been referred, has taken these matters under consideration and begs leave to report:—

(1) The committee is of opinion that no recommendation concerning national legislation should be made by this Association.

(2) The committee recommends that the communication presented by Mr. de Ghequier be spread on the minutes.

(3) The conditions in the different States are so various that it is clearly impracticable to draft a uniform law covering the details of inspection, regulation of sale, &c., of commercial fertilisers that would be generally acceptable.

(4) With the legal and commercial features of such legislation this Association has nothing to do. The form of statement of the analysis of fertilisers is a matter, however, the discussion of which is clearly within our province. The committee suggests the following as a proper form in which guaranteed and official analyses should be expressed:—

	Per cent.
Moisture	
Soluble phosphoric acid..	
Reverted phosphoric acid	
Insoluble phosphoric acid	
Total available phosphoric acid	
Total phosphoric acid	
Nitrogen	
Equivalent to ammonia	
Potash (K_2O)	

The committee further suggests that the same form, or such part or parts of it as may be necessary, be recommended as proper to be attached to bags or packages containing fertilisers.

And the committee recommends that each member of this Association use his influence to have a clause inserted in the fertiliser law of his State looking to the adoption of the forms of analysis above expressed.

Respectfully submitted,

H. C. WHITE, Chairman.
P. E. CHAZAL.
E. H. JENKINS.

Professor STUBBS moved to strike out the words "total available" in the form recommended by the committee, which was carried, and the report was then adopted.

(To be continued.)

A METHOD FOR THE SEPARATION OF SODIUM AND POTASSIUM FROM LITHIUM BY THE ACTION OF AMYL ALCOHOL ON THE CHLORIDES,

With some Reference to a Similar Separation of the Same from Magnesium and Calcium.*

By F. A. GOOCH.

(Continued from page 30.)

Used simply to wash the precipitate, amyl alcohol cannot, of course, exert an effect at all comparable with that manifested in the experiments which have been described, but to know just what this action may be is important. Experiments (18) to (22) were undertaken, therefore, to elucidate this point.

* *Proceedings of the American Academy of Arts and Sciences*, 1886-1887.

Weighed amounts of the test solutions were evaporated nearly to saturation in small glass beakers amyl alcohol added, and, as in the previous experiments, the whole heated until the salt had deposited and the residual alcohol had boiled quietly for some minutes at its ordinary boiling point, the liquid decanted, filtered under gentle pressure by means of a weighed perforated crucible and felt of asbestos, the filtrate measured, the residue dislodged with the aid of a rubbing-rod and transferred to the crucible and washed with anhydrous amyl alcohol, the washings being collected and measured. The crucible and contents were dried over a free flame turned low so that the heat should not reach the melting-point of the chlorides.

These results show very plainly that the solvent effect of anhydrous amyl alcohol used for washing under the conditions described is trifling in the extreme, and may be neglected utterly providing the amount of the washing is not altogether disproportionate to the needs of the case.

We pass next to the consideration of the separation of

	Weight of NaCl taken.	Weight of NaCl found.	Weight of NaCl found, corrected for solubility in residual amyl alcohol.	Error of corrected weight of NaCl found.	Volume of residual amyl alcohol.	Volume of amyl alcohol in washings.
	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³
(18)	0·0947	0·0937	0·0947	0·0000	24	44
(19)	0·1080	0·1074	0·1082	0·0002+	19	53

	Weight of KCl taken.	Weight of KCl found.	Weight of KCl found, corrected for solubility in residual amyl alcohol.	Error of corrected weight of KCl found.	Volume of residual amyl alcohol.	Volume of amyl alcohol in washings.
	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³
(20)	0·1846	0·1837	0·1847	0·0001+	20	60
(21)	0·1964	0·1946	0·1961	0·0003−	30	45
(22)	0·1857	0·1839	0·1854	0·0003−	30	60

	Weight of NaCl taken.	Weight of NaCl found.	Weight of NaCl found, corrected for solubility in amyl alcohol.	Error in weight of NaCl found.	Error in corrected weight of NaCl found.	Volume of amyl alcohol used. Residual.	Volume of amyl alcohol used. Total.
	Grm.	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³
(23)	0·1089	0·1092	0·1095	0·0003+	0·0006+	7	70
(24)	0·1084	0·1085	0·1090	0·0001+	0·0006+	12	80
(25)	0·1074	0·1067	0·1074	0·0007−	0·0000	18	90

	Weight of LiCl taken.	Weight of Li_2SO_4 found.	Weight of LiCl found.	Corrected weight of LiCl found.	Error in weight of LiCl found.	Error in corrected weight of LiCl found.
	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
(23)	0·1298	0·1682	0·1299	0·1296	0·0001+	0·0002−
(24)	0·1227	0·1592	0·1230	0·1225	0·0003+	0·0002−
(25)	0·0116	—	—	—	—	—

	Weight of KCl taken.	Weight of KCl found.	Weight of KCl found, corrected for solubility in amyl alcohol.	Error in weight of KCl found.	Error in corrected weight of KCl found.	Volume of amyl alcohol used. Residual.	Volume of amyl alcohol used. Total.
	Grm.	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³
(26)	0·2051	0·2036	0·2053	0·0015−	0·0002+	34	100
(27)	0·2022	0·2013	0·2032	0·0009−	0·0010+	37	100
(28)	0·2109	0·2096	0·2104	0·0013−	0·0005−	16	100
(29)	0·0984	0·0970	0·0980	0·0014−	0·0004−	20	90

	Weight of LiCl taken.	Weight of Li_2SO_4 found.	Weight of LiCl found.	Corrected weight of Li Cl found.	Error in weight of LiCl found.	Error in corrected weight of LiCl found.
	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
(26)	0·1256	0·1638	0·1265	0·1248	0·0009+	0·0008−
(27)	0·1287	0·1677	0·1296	0·1277	0·0009+	0·0010−
(28)	0·0113	—	—	—	—	—
(29)	0·0113	—	—	—	—	—

	Weight of NaCl taken.	Weight of KCl taken.	Weight of NaCl+KCl found.	Corrected Weight of NaCl+KCl found.	Volume of Amyl Alcohol used. Residual.	Volume of Amyl Alcohol used. Total.
	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³
(30)	0·1053	0·1031	0·2064	0·2084	22	100
(31)	0·1051	0·0945	0·1988	0·2003	16	80

	Weight of LiCl taken.	Error in Weight of NaCl+KCl found.	Error in corrected Weight of NaCl+KCl found.
	Grm.	Grm.	Grm.
(30)	0·0113	0·0020−	0·0000
(31)	0·0113	0·0008−	0·0007+

the chlorides of sodium and potassium from lithium chloride. Weighed portions of the test solutions were concentrated and treated with amyl alcohol in the manner described until the precipitated salt was entirely free from water and the supernatant alcoholic solution of the lithium chloride boiled constantly at a point not far from that of the amyl alcohol employed. Then the liquid was cooled, a drop or two of strong hydrochloric acid added in accordance with the evident suggestion of the preliminary experiments previously mentioned, and heat again applied until the boiling had continued, as before, for some minutes at one point. The filtration, washing, drying, and weighing of the residue were effected as in experiments (18) to (22). In those of the experiments in which the lithium salt in solution was also determined, the end was accomplished by evaporating the filtrate and washings to dryness, treating the residue with sulphuric acid, and igniting and weighing as lithium sulphate. In the table (see p. 40) the weight of insoluble chloride actually found is given in one column, and this weight, corrected according to the data previously determined for the solubility of the chloride in the residual amyl alcohol appears in the column adjoining. So also the weight is given of the lithium sulphate actually found, and an adjacent column contains the result of correcting this weight for the accompanying sodium or potassium sulphate, or both, upon the hypothesis that these salts are neutral sulphates after the ignition. In the case of quantities so minute the error which is introduced by such an assumption cannot be considerable, and in relation to this point Dittmar* maintains that comparatively large amounts of acid sodium or potassium sulphate may be reduced to the neutral salt by ignition simply. The figures of the column showing the weights of lithium chloride found are derived by calculation from the weights of lithium sulphate actually found. The other headings of the table are sufficiently intelligible without further explanation.

It will be noticed that in experiments (23), (24), (26), and (27), the corrected error in the weight of the insoluble chloride has a positive value ranging from 0·0002+ grm. to 0·0010+ grm. with a mean of 0·0006+ grm.; and that in experiments (25), (28), (29), (30), and (31) the mean error is negative, amounting to less than 0·0001− grm., with a range from 0·0005− grm. to 0·0007+ grm.

(To be continued.)

* "Report on Researches into the Composition of Ocean Water, collected by H.M.S. Challenger during the Years 1873—1876," p. 18

ON THE ANALYSIS OF OPIUM.

By CHARLES M. STILLWELL, M.A.

In presenting a method for the analysis of opium, as an addition to the many processes published from time to time, I feel justified on account of the importance which a correct analysis of this costly substance demands. I lay claim to no special originality in the general method of the analysis to be described. Based as it is upon the processes used by Dr. Squibb for the sampling of the opium and the mode of extraction and precipitation of the morphia, I have attempted to render these still more effective by such modifications as I find necessary in the course of the analysis. The use of the two washing solutions, to be described hereafter, is an important step toward obtaining a pure precipitate of morphia; and the final purification of the crystalline precipitate, proposed by myself, I find to be absolutely necessary for the correctness of the analysis. To this latter point I call special attention. The process of Dr. Squibb, used as he directs, will give results which are almost exactly comparable among themselves. It can be used, therefore, as a control; but to obtain analytical results such as are needed for buying and selling, a still greater degree of accuracy is required. For this purpose I believe the method now to be described to be of great value. It is presented somewhat more in detail than may seem necessary, but I find in my practice that much of the value of an analytical process depends upon these small and seemingly insignificant points. For the analysis of a substance so complex in its nature as opium, it is necessary that the process used should be simple, easy of manipulation, but yet thoroughly successful in the extraction of all the morphia present. The solvent used and the bulk of the solution obtained should be such that the least possible amount of injury is done to the alkaloid during the course of the analysis.

In Allen's "Commercial Organic Analysis" is found the following account of the—

Action of Solvents on Opium.—The action of different solvents and reagents on opium is shortly as follows:—

"Water dissolves meconic acid readily, as also meconate and acetate of morphia; free morphia very sparingly, and narcotine still less so (1 in 1000). Narceine is more soluble than morphine, while the resin, caoutchouc, &c., are insoluble, though certain gummy matters pass into solution.

"Alcohol dissolves free morphia, as well as the acetate and meconate. The other alkaloids of opium, as also the resin and caoutchouc, are dissolved by alcohol.

"Amylic alcohol dissolves all the alkaloids of opium, if in a free state. The resin is also slightly soluble in amylic alcohol.

"Ether, benzene, and carbon disulphide dissolve about 0·05 per cent of free morphia, and the other free alkaloids of opium more readily. These solvents also dissolve the caoutchouc, but not the resin.

"Acids dissolve all the alkaloids from opium, together with the resin.

"Fixed alkalies used in excess dissolve morphine freely, while narcotine remains insoluble. Lime water dissolves morphine, but is a solvent for narcotine only in presence of morphine. The resin of opium is partly soluble in alkalies.

"Ammonia dissolves morphia sparingly, narceine and codeine readily, while the other alkaloids and the resin of opium are insoluble.

"From the foregoing statements, the arrangement of which is mostly due to Mr. E. L. Clever,* it follows that an aqueous solution of opium will contain meconate of morphine and other alkaloids, calcium salts, meconic acid, extractives, and resinous matter dissolved by the free acid present.

"An alcoholic solution will contain, in addition to the above, free narcotine, caoutchouc, fat, and resin.

"Opium which has been exhausted with water still retains a bitter taste; but this is probably due to narcotine, as it is removed by carbon disulphide, benzene, or ether, in which morphine and its salts are insoluble. If the aqueous solution be distinctly acid, water may be trusted to dissolve the whole of the morphia from opium. In some processes of assaying opium the sample is subjected to a preliminary treatment with benzene or ether to remove narcotine, caoutchouc, and colouring matter. By this means the subsequent exhaustion with water is much facilitated and a purer solution of morphine is obtained.

"In presence of much narcotine, morphine is soluble in benzene, but this is not true of the meconate or other *salts* of morphine. Hence there is no loss of morphine on extracting opium with benzene. Meconate of morphia is, however, freely soluble in a mixture of alcohol and chloroform, but the simultaneous presence of ether prevents its solution more or less completely. . .

"The ash of opium is readily determined by igniting a weighed quantity of the sample. The residue should not exceed 8 per cent.

"An aqueous solution of opium should give a red colouration with ferric chloride. The production of a

* *Year-Book of Pharmacy*, 1876, p. 502.

black or blue-black colouration or precipitate will be due to tannin, which is not a normal constituent of opium.

"Genuine opium contains no starch, and hence, on boiling with water the residue insoluble in cold water, the solution obtained should give no blue colouration with solution of iodine.

"Sand, stones, bullets, and other make-weights are sometimes met with as adulterants of opium. Sugar, gum tragacanth, pulp of apricots and figs, pounded poppy capsules, &c., are also employed for the sophistication of opium."

Of the many processes published for the estimation of morphia in opium, none have proved thoroughly successful and easy of accomplishment. In an article by Dr. E. R. Squibb, published in *Ephemeris*, Jan., 1882, is found a full account of a process used by him, and based upon one published by Prof. Flückiger some two years previous. The reader is referred to the article for the full text of the description, but the essential points are described below. The modifications of the original process introduced by Dr. Squibb, though slight, have great value, because they lead to a thorough exhaustion of the opium and a better crystallisation of the morphia.

Those analytical processes which depend on the use of lime and on the use of an aliquot portion of the filtrate are unsatisfactory, because they do not thoroughly exhaust the opium; because the discarded portion is richer in morphia than the aliquot portion taken; and, lastly, because the volume of liquid used is too large to allow of the full separation of the morphia. These points were examined by Dr. Squibb, who found in an opium of known strength that the first portion of the solution gave 0·544 grm. of morphia, the discarded portion gave 0·595 grm., and the two together did not account for the total amount of morphia present by about 1 per cent. This loss of morphia was found to be due to the large volume of solution used for the precipitation. A test made by myself on this point gave the following results:—10·18 grms. of an opium, which gave, by the process hereafter to be described, 11·76 per cent morphia, was thoroughly exhausted, and the filtered solution evaporated to 100 c.c. The requisite amounts of alcohol, ether, and ammonia were added. The precipitate obtained weighed 1·020 grms., equal to 10·00 per cent. The filtrate from the crystals was evaporated to 25 c.c. and the requisite amounts of alcohol, ether, and ammonia added, and a further precipitate of morphia weighing 0·155 grm. was obtained, equal to 1·52 per cent. The total amount found was, therefore, 11·52 per cent. In a pure salt of morphia this effect of dilution is not so important. A crystallised sulphate of morphia, which, if pure, should contain 75·2 per cent morphia, was dissolved and the morphia crystallised from a total volume of 120 c.c. of solution. The crystals obtained equalled a percent of 74·31. On evaporation of the filtrate to 25 c.c., and recrystallisation, 0·20 per cent more was obtained, giving a total of 74·51 per cent morphia.

Trails made to test the accuracy of using an aliquot portion of the solution gave results too discordant to be of any service. In one case I obtained 10·63 per cent instead of 11·76 per cent, the actual amount in the opium.

As regards the accuracy of the process about to be described, the following results may be of interest:—A lot of opium, very uneven in quality, was sampled by one of our men, and I made the analysis, obtaining—Water, 24·30; morphia, 11·75 per cent. Three months afterwards the same lot was re-sampled by myself and one of our men, and the resulting sample analysed by me, in duplicate, using different weights of opium for each analysis. The results obtained were—Water, 24·70; morphia, 11·70 and 11·82; average, 11·76 per cent. Other results of duplicate tests showing the same agreement might be given if necessary.

Sampling.—The process of sampling and the preparation of the sample are of great importance, as, on account of the varying quality of the lumps of commercial opium, it is very unlikely that any two lumps will be of the same strength. About every tenth lump in a case is sampled by cutting a cone-shaped piece from the middle of the lump, with an ordinary pocket-knife. From the side of this cone a small strip is taken, and the cone returned to its place in the lump. These separate strips are kept in a tin box until the sampling is finished, care being taken that they do not lose moisture by exposure.

Preparation of the Sample for Analysis.—The sample, composed as it is of many small pieces, is treated as follows:—A slab of glass or stone about two feet long is provided, though a small board of hard wood will answer. On this this the mass of samples is rolled with the hands, until it is worked into a long thin roll. This is doubled upon itself and rolled again, re-doubled and re-rolled, and so on until a section cut anywhere from the roll shows a perfectly homogeneous surface. The ease with which this is done depends upon the condition of the sample; a moderately dry sample—that is, with 10 to 12 per cent of water—will roll out very easily without sticking to the hands, while a wetter one will give some trouble; but with care the sample can be made perfectly uniform in so short a time that no loss of moisture will take place. The sample when prepared is wrapped in tin-foil, and placed in a suitable box or bottle to be kept for analysis.

If the sample be hard and dry, and cannot be mixed by the above method, break it up coarsely, take an average portion for moisture, and dry in the water-bath an average of the remainder, until it is possible to grind it in a mortar to a sufficiently fine powder. Determine the moisture and the morphia in the prepared sample. Then, by calculation, the result is reduced, first, to the amount present on a dry basis, and then to that present in the original sample. If the sample for analysis is powdered opium, no difficulty will occur in getting a fair average sample.

Moisture.—Two separate portions of the average sample, from 6 to 8 grms. each, are weighed and dried at 100° C. From samples prepared as above described, duplicates for moisture will agree very closely. For example:—

1:	24·70	23·13	22·90	20·30	17·90	20·60
2.	24·70	23·40	22·70	20·60	17·50	20·70
Average	24·70	23·26	22·80	20·45	17·70	20·65

Determination of the Morphia.—Weigh off a portion of the average sample, using about 10 grms., noting the exact weight of the portion taken.

"Put the weighed portion into a flask or common wide-mouthed bottle of 120 c.c. capacity, fitted with a good cork. Add 100 c.c. of water, distilled by preference—but this is essential only when common water contains an unusual amount of inorganic matter—and shake well. Allow it to macerate over night or for twelve hours, with occasional shaking, and then shake well and transfer the magma to a filter of about 10 centims. = 4 inches diameter, which has been placed in a funnel and well wetted. As it is the shaking which accomplishes the object here in view, rather than the standing, the time of maceration can be easily shortened even to three hours, if the shaking be frequent and active."*

Instead of using a flask or bottle I place the weighed portion in a strong beaker, add 100 c.c. water, and then, with a glass rod fitted at the end with a piece of thick rubber tubbing, I rub and break up the lump of opium, until in a short time it is thoroughly disintegrated. It is best to let the opium stand some hours in order that the morphia be thoroughly extracted. In test assays it was found that if the solution were filtered off as soon as the lump of opium was broken up and no more dark, soft portions were seen, the amount of morphia obtained was less than the actual amount present. Duplicates made in this manner—by filtering as soon as the dark soluble portions were dissolved—did not agree; but by repeating the

* *Ephemeris*, i., 15.

operation and allowing the opium to digest over night, the duplicates, made with different amounts of opium, agreed exactly in the amount of morphia obtained. The beaker is covered with a watch-glass and placed where no ammoniacal vapours will affect it, although, as the water solution is acid from the organic acids present in the opium, no precipitation of morphia will take place until this acidity be neutralised.

I learn from Dr. Squibb that he has lately adopted the plan of adding a few drops of sulphuric acid to the water used for the exhaustion of the opium. The solution is kept slightly acid, and the extraction of the morphia seems to be thereby facilitated.

"As rare exceptions, some powdered opiums will be found which, through natural conditions, give a magma with water which will not filter, or filter so very slowly that the water solvent becomes impracticable. When this is discovered the magma is thrown away and a fresh portion of powder is taken. Wash this by agitation in a bottle with 30 c.c. of ether (sp. gr. 0·728), transfer it to a filter, rinse the bottle with 20 c.c. more of ether, and pour this on to the opium in the filter. When this has passed through, wash the filter and opium with 10 c.c. more ether, applied drop by drop around the edges of the filter and on the surface of the opium. Then dry the powder on the filter and use it as in the case of opium, which does not need to be first washed with ether.

"Opium which is adulterated, or standardised by admixture with dextrine, gums, sugar, or glucosides, yields an impracticable magma with water, and ether-washing to such does little or no good. All such samples have to be exhausted with an alcoholic solvent. If not much adulterated a mixture of equal measures of alcohol (sp. gr. 0·820) and water will answer best, but generally a mixture of two measures of alcohol (sp. gr. 0·820) with one measure of water is to be used, instead of water alone, for the exhaustion, and as this mixture is not as good a solvent for the morphia salts in the opium as water, more of it is required, and the washing and percolating should be carried to 250 c.c. of solution from the 10 grms. of opium. The process after exhaustion is the same as where water is used as the solvent."*

(To be continued.)

* *Ephemeris*, i., 15.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, January 20th, 1887.

Dr. Hugo Müller, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Leonard Dobbin, Ph.D., 4, Cobden Road, Edinburgh; Edgar Hall, Town House, Queenboro', Kent; Alexander Hay, 84, West Parade, Lincoln; John Steele Jackson, The College, Epsom; George McGowan, Bangor, North Wales; Henry Droop Richmond, Park Lane, Tottenham; Arthur H. F. Kuppel, 52, Parrock Street, Gravesend; Henry Lloyd Snape, B.Sc., The Technical School, Manchester; W. Scrutton, University College, London; Arthur Stanley, 38, Trebovir Road, Earl's Court, S.W.; Henry Weston Wallis, 7, Auckland Road, Clapham Junction, S.W.

The following papers were read:—

1. "*Some Silicon Compounds and their Derivatives.* By J. Emerson Reynolds, M.D., F.R.S.

Although large numbers of silicon analogues of carbon compounds are known, it is pointed out that we do not find among the former any well-defined representatives of cyanogen and its derivatives. The present investigation was commenced some years ago with the primary purpose of obtaining such compounds, if possible, and generally of examining reactions in which the silicon haloids—particularly the tetrabromide—and organic nitrogen compounds take part. In the course of the work a number of new bodies have been obtained, only a few of which can, however, be regarded as cyanogen derivatives.

The author, in this the first paper of a series, describes the action of silicon tetrabromide on thiocarbamide, as the products obtained in this branch of the enquiry were exhibited at the *conversazione* of the Royal Society last June.

It is shown that silicon tetrabromide in benzene solution acts in a very remarkable manner with thiocarbamide, the latter affording a condensed amide with which the tetrabromide unites. Eight molecules of thiocarbamide combine with only one of silicon tetrabromide at the temperature of boiling benzene. Attempts to make this amide unite with a larger proportion of the bromide only lead to decomposition. The product is a thick liquid at a temperature 65° C., below the fusing-point of pure thiocarbamide (140° C.), and becomes solid at ordinary temperatures. Solvents of the tetrabromide do not extract any from this product, nor is it dissolved by any liquid without decomposition.

When boiled with anhydrous alcohol it affords a monobromo-derivative of pentathiocarbamide, which is obtained from the alcoholic solution in beautiful groups of silky crystals. At the same time bromethyl-thiocarbamide and bromethyl-dithiocarbamide are obtained along with ethylic silicates.

Discussion.

In reply to Mr. Rideal, Prof. Reynolds said that in preparing silicon tetrabromide it was essential to use silica which had been precipitated in the gelatinous form, and to mix it most intimately with the carbon (lampblack); the action of the bromine took place at an extremely high temperature. Replying to the President's question, Had analogous compounds been obtained from urea? he said that urea did react with silicon tetrabromide, but not in the same way as thiocarbamide.

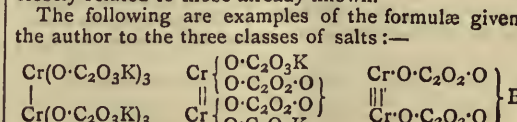
Dr. Armstrong remarked that, assuming the bromine to be the linking agent, it was noteworthy that in the silicon compound, and also in that of ethyl bromide with thiocarbamide, the ratio was $Br : 2CSN_2H_4$: this perhaps might be regarded as an indication that the thiocarbamide molecule had at least the formula $C_2S_2N_4H_8$; the ratio in the remarkable compound with bromine was, however, different.

2. "*Chromo-organic Acids.* Part I. *Certain Chromoxalates.*" By Emil A. Werner.

This paper contains an account of the salts resulting from the combination of chromium oxalate with certain metallic oxalates. A study of these compounds has led to the conclusion that they cannot be considered as ordinary double salts, but are in point of fact salts of complex chromoxalic acids. A similar view of the constitution of these compounds was advanced by Malaguti in 1843, but strange to say has been entirely ignored, since all workers with these particular compounds (with the exception of Clarke and Kebler) have treated them as double or triple salts. Malaguti's view has been considerably extended, and new experimental evidence furnished in support of it; it has also been shown that the oxalic radicle can be displaced by those of other organic acids, salts of which have been obtained.

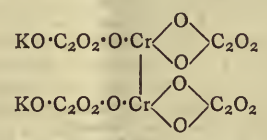
The paper concludes with the description of a new series of chromoxalates, whose members are shown to be closely related to those already known.

The following are examples of the formulæ given by the author to the three classes of salts:—



Discussion.

Dr. Japp thought that some of the provisional constitutional formulæ proposed by the author for the various series of chromoxalates were open to criticism. In the formula for the salt of the "red series," for example, two oxygen-atoms, united to oxalic acid radicles, were represented as satisfying each other's affinities—an arrangement which would place these stable salts in the same category as the explosive peroxides of acetyl and benzoyl, whilst at the same time the two chromium-atoms in the formula were doubly linked. It was only necessary, however, to suppose that these vacant affinities of the chromium-atoms were satisfied by those of the oxygen-atoms in order to represent the salts as perfectly normal, thus:—



The constitution of the salts of the "green series" was still more anomalous, as in these the chromium was represented as existing in a less saturated state than that in which it occurs in the chromous compounds.

Mr. J. M. Thomson drew attention to the interesting dichroic properties of the chromoxalates, the dichroism being especially marked in the case of the calcium salt described by Prof. Hartley. The difference in the extent to which they exhibit dichroism was very remarkable, as it distinctly decreased as the atomic weight of the metal forming the double chromoxalate increased, the dichroism of the potassio-baric chromoxalate being small compared with that of the potassio-calcic chromoxalate or the potassio-lithic chromoxalate. Had the author observed the same diminution of dichroism with increase in molecular weight in the salts formed from the organic bases which were mentioned in the paper? With the object of further examining the optical properties of these compounds, the speaker had recently prepared double potassio-chromoxalates containing nickel and cobalt; these salts, however, presented no specially marked dichroic properties. They are also more soluble than the calcium or barium salts, and more difficult to crystallise.

Dr. Forster Morley said that the "red salt," as formulated would be a chromous salt; spectrum analysis might be expected to throw light on the question whether it actually was a compound of this order. From observations recently made in the laboratory of the University College, it appeared that the difference between the blue and red chromoxalates was of the same nature as between the known blue and red chromic salts.

Dr. Armstrong, agreeing with the previous speaker, said that a chromous salt, such as the red salt was represented to be, ought, like all chromous salts, to be a powerful reducing agent: not a word was said in the paper to indicate that such was the case. The green salt, according to the formula given, would be still more oxidisable: it was inconceivable that such a salt should be formed in presence of alkali and air. He thought all three were chromic salts.

Prof. Reynolds, by whom the paper was read, said, in reply, that differences in dichroic properties, such as were referred to by Mr. Thomson, had been noticed in the case of the salts of organic radicles. The author was studying the spectroscopic behaviour of the salts described.

3. "*Note on the Constitution of the Double Chromic Oxalates.*" By W. N. Hartley, F.R.S.

Some years ago (*Proc. Roy. Soc.*, xxi., 499) the author described a remarkable dichroic salt, a potassio-calcium chromoxalate, and at the same time he prepared a large number of similar salts, the analyses of which were not completed in time for publication. These were potassio-chrome oxalates containing strontium, barium, lithium, and thallium. Excepting the lithium salts they did not possess any striking optical properties. They crystallised freely.

On account of the manner in which these salts were formed, for instance:—

a. By dissolving chromic hydrate in oxalic acid, and adding the bases or their carbonates;

b. By preparing the red potassium chromic oxalate, $Cr'''KC_4O_8{\cdot}3H_2O$, and adding neutral potassium oxalate thereto;

Also by reason of their reactions with calcium, strontium, and barium salts, he came to the conclusion that they were really derivatives of a distinct acid which might be termed chromoxalic acid, and the formula following would represent its constitution—$Cr'''O_3(C_2O{\cdot}OH)_3$.

The following reasons may be stated as affording grounds for this view:—

1. The chromium is not precipitated by alkalies.

2. When alkali is added a soluble salt of the alkali is produced instead of a precipitate of chromic oxide or hydrate.

3. The carbonates of the alkalies give soluble salts of the alkalies and no precipitate.

4. The formula given is the only one which explains the formation of such salts as $K_3Cr'''{\cdot}3C_2O_4$.

5. The blue salts such as $K_3Cr'''{\cdot}3C_2O_4$ are *formed with greater facility* than the red salt $KCr'''{\cdot}2C_2O_4$.

6. The blue salts give none of the reactions which are characteristic of oxalates, such as precipitation with chlorides of calcium, barium, &c.

7. The blue salts can be formed from the red, and the potassio-calcium chromic oxalate can be made by boiling calcium oxalate with the red salt according to the equation—

$$\left.\begin{matrix}K\\Cr'''\end{matrix}\right\}2(C_2O_4) + Ca''C_2O_4 = \left.\begin{matrix}KCa''\\Cr'''\end{matrix}\right\}3(C_2O_4).$$

4. "*Remarks on Recent Papers by A. Baeyer and J. Thomsen on 'The Constitution of Benzene.'*" By Alex. K. Miller, Ph.D.

The author contends that most of Baeyer's arguments fail to carry much weight, since they are based on reactions which admittedly involve intramolecular changes. Such reactions might be used with equal force either in support of or against almost any formula, according to the way in which the isomeric change be assumed to take place. It is shown, for instance, how the conversion of dihydroxyterephthalic ether into succinosuccinic ether may be explained with the help of the prism formula as readily as with Kekulé's symbol. The author also points out a weak point in the argument which Baeyer brings forward against the prism formula. Finally it is pointed out that Baeyer's arguments in support of the existence of a double bond in benzene are founded upon data which may perhaps be used as an argument in favour, but certainly do not prove the existence, of a pair of double bonds.

With reference to Thomsen's octahedral symbol for benzene, it is stated that the advantages claimed for it, namely, that it is a perfectly symmetrical space representation which admits of three possible disubstitution-derivatives, and three only, are perfectly well founded. It is, however, pointed out that the symbol differs in some important respects from Kekulé's symbol; it is impossible, for instance, to represent quinone as a diketone, the only representation possible being that in which each oxygen-atom is united by one affinity only to a carbon-atom; another difference is that Thomsen's symbol renders possible *four* disubstitution-derivatives of hexahydrobenzene. Finally, certain synthetical reactions, such as the formation of succinosuccinic ether from succinic ether, cannot well be represented with the aid of the symbol in question.

In conclusion, the author expresses the opinion that neither Baeyer's nor Thomsen's paper has contributed to the solution of the problem of the constitution of benzene.

At the next meeting, on February 3rd, there will be a ballot for the election of Fellows, and the following papers will be read:—

"An Explanation of the Laws which govern Substitution in the case of Benzenoid Compounds," by Dr. Armstrong. "The Synthetical Formation of Closed Carbon Chains. Part II. Some Derivatives of Tetramethylene," by Dr. W. H. Perkin, jun., and H. Coleman. "Part III. Some Derivatives of Pentamethylene," by Dr. W. H. Perkin, jun.

PHYSICAL SOCIETY.

January 22nd, 1887.

Prof. H. McLEOD, F.R.S., Vice-President, in the Chair.

DR. F. WORMACH was elected a member of the Society.

The following papers were then read:—

"*The Permanent and Temporary Effects on some of the Physical Properties of Iron, produced by raising the Temperature to* 100° *C.*" By Mr. HERBERT TOMLINSON, B.A.

The paper is divided into three sections: 1st, Internal Friction of Iron; 2nd, The Longitudinal and Torsional Elasticities of Iron; and 3rd, The Velocity of Sound in Iron.

In his experiments on the internal friction of metals, the author uses a vertically suspended wire, rigidly clamped at its upper extremity, and having its lower end secured to a horizontal bar of metal, attached to which are two cylinders of equal mass and dimensions, placed at equal distances from the wire. When the system is set in torsional oscillation the amplitude gradually diminishes, due to the internal friction of the metal and the friction of the air. The combined effect is measured by the logarithmic decrement of the oscillations, and the air effect eliminated by Prof. Stokes's formulæ and the author's experimental determination of the viscosity of air. When the deformations are sufficiently small the experiments prove that the logarithmic decrement of air is independent of the amplitude and period of vibration. These results are only true when the wire has been allowed to rest a considerable time after any change has been made in the arrangement, and when there have been a large number of oscillations executed previous to the actual testing.

Reference is made to some experiments by Prof. G. Wiedemann, which show that when a wire is subjected to torsional stress it does not recover itself when the stress is gradually reduced to zero, but remains permanently twisted through a small angle (say θ). By reversing the twisting couple there is a permanent set on the other side of the initial position. If the operations be repeated, θ diminishes and attains a minimum. The period during which this diminution takes place is called the "accommodation period."

When a wire is in torsional vibration the position of equilibrium is continually shifting to and fro, through twice the above minimum angle, and Wiedemann considers the loss of energy to be due to this shifting. The author's experiments verify Wiedemann's results, and also show that time and temperature have great effect on the internal friction. By repeatedly heating to 100° C. and slowly cooling an annealed iron wire for six days, the logarithmic decrement due to internal friction was reduced to about one-eighth its original amount, at the same temperature, and when the wire was maintained at 98° C. the decrement was reduced to 1-30th.

The author considers the permanent diminution produced by heating and cooling to be mainly due to the slow shifting backwards and forwards of the molecules, induced by that process.

In the second part of the paper it is shown that the effects of change of temperature on the longitudinal and torsional elasticities of iron and steel are not nearly so great as that produced on the internal friction. Thus, by heating annealed iron wire its longitudinal and torsional elasticities are slightly decreased, but on cooling there is a permanent increase in both. Time is also an important element, for a long rest after cooling still *further* increases both elasticities. From the above results it is evident that the velocity of sound in iron and steel must *diminish* with rise of temperature. This was experimentally proved before the meeting. Attention was particularly directed to this fact because most of the best text-books make the opposite and erroneous statement.

Remarks were made by Mr. C. V. BOYS, and the CHAIRMAN mentioned a new form of clock whose action depends on torsional elasticity of a steel wire.

"*On some New Measuring Instruments used in Testing Materials.*" By Prof. W. C. UNWIN, F.R.S.

In most measuring instruments previously used it has been considered sufficient to make the measurement of elongation from one side of the bar, but this, the Professor showed, was liable to serious errors owing to the fact that test bars are not always perfectly straight, and to the possibility of originally straight bars being bent by improper fixing in the testing machine. In such cases the modulus of elasticity calculated from the apparent elongations are subject to considerable error. In endeavouring to overcome these difficulties the author has devised several new forms of measuring apparatus, which are attached to two sides of the bar by steel points, and the mean elongation of the two sides determined.

The first apparatus described consists essentially of sliding callipers read by a microscope to 1-10,000th of an inch. Another form has two clamps provided with sensitive levels. Each is attached to the bar by two steel points, the line joining which is perpendicular to the direction of the stress, and the clamp can rotate in a vertical plane about this line as an axis. The lower clamp is levelled by a screw pressing against the surface of the bar, and the upper one by means of a micrometer screw parallel to the axis of the bar, the nut of which is secured to the bottom clamp. By this means the elongation can be measured to 1-10,000th of an inch. In a third form two similar clamps without levels are kept apart by a steel rod ending in knife edges. One of the clamps carries a small roller, which turns about an axis parallel to the line joining the steel points above mentioned, and the axis carries a small plane mirror. The other clamp supports a projecting arm parallel with the axis of the test piece, and which presses on the surface of the roller. When the bar is elongated the mirror is turned through a small angle, and the elongation is determined by a reading telescope and vertical scale, to 1-100,000th of an inch. A similar apparatus is used for testing the compression of stone, but in this the compression is multiplied by a lever and measured by a micrometer microscope to 1-100,000th of an inch.

Mr. C. V. BOYS directed attention to some beautiful photographs of the solar spectrum just received from the Johns Hopkins University, which had been obtained by Prof. Rowland's concave gratings.

At the conclusion of the meeting Prof. Unwin invited the members to visit the Engineering Laboratory of the City and Guilds of London Central Institution, where he broke a bar of Staffordshire iron in the 100 ton testing machine, the force and elongation being automatically recorded.

Absorption Spectrum of Oxygen.—Prof. Olszewski laid before the Vienna Academy of Sciences determinations of the boiling-point of pure ozone (−106°), and the congealing-point of ethylene (−169°), whereby he used liquid oxygen as a refrigerant. He has determined the absorption spectrum of the latter, and observed two conspicuous bands. One band is in the red, to the right of Frauenhofer's C line, and the second in the yellow, to the right of D. Both agree with the telluric absorption-bands of the solar spectrum, corresponding to the wave-lengths 629 μ and 577 μ both in position and appearance.—*Chem. Zeitung.*

NOTICES OF BOOKS.

The Toxicity of Silicon Fluoride. By Sir Charles A. Cameron, M.D., Ex-President and Professor of Chemistry and Hygiene, R.C.S.I.

This pamphlet is a reprint from the *Dublin Journal of Medicine* for January, 1887, and it is of interest to the manufacturer of artificial manures, to sanitarians, and to physiologists.

The author accounts for the death of two men who worked in an artificial manure works, on the assumption that they inhaled silicon fluoride, a gas evolved in making superphosphate of lime. He shows that the phosphate used in the works contained 6·36 per cent of calcium fluoride, and that a ton of it, if treated with a full complement of sulphuric acid, would evolve 32·78 cubic metres of silicon fluoride gas. He gives elaborate accounts of his examination of the lungs, heart, &c., of the last man killed, as he believes by inhaling silicon fluoride, and, from this examination and from the symptoms during illness concludes that fluoride of silicon caused his death. In the lungs traces of fluorine and 0·75 grm. of silica were found.

Experiments made with rats and guinea-pigs proved that silicon fluoride was more poisonous than carbonic oxide; 0·5 per cent rendered air rapidly fatal to a guinea-pig.

The author shows that silicon fluoride is more complex in its physiological action than carbonic acid. It causes partial asphyxia by depositing colloid silica in the bronchi and in the air vesicles of the lungs, which is not absorbable into the circulation. Unlike CO_2 it does not appear to affect the psychical nerve-cells, as the two men poisoned by the gas were conscious to the last. The fluosilicic acid which the silicon fluoride forms on coming into contact with the moist respiratory passages is taken up into the circulation, and it apparently acts directly upon the filaments of the pneumogastric nerve which come directly in contact with it, and it probably also acts on the inhibitory ganglionic centres in the walls of the heart, already embarrassed by the impure condition of its blood due to deficient aëration: in this case the immediate cause of death would be failure of the heart's action, the patient retaining consciousness to the last.

The author believes that the fluosilicic acid acts as a poison to the nerve-centres controlling respiration, and believes that the solid fluosilicic acid acts as a mechanical stimulus to the nerves of the smaller bronchi, causing their muscles to contract spasmodically, and thereby diminishing the area of the passages from the trachea to the air-vesicles of the lungs.

The Retrospect of Medicine. Being a Half-yearly Journal, containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by James Braithwaite, M.D. (London). Vol. xciv. July—December, 1886. London: Simpkin, Marshall, and Co.

This useful repertory contains nothing novel concerning the action, the detection, or the extirpation of deadly microbia. Nor do we find any discussion on Pasteur's treatment of hydrophobia.

Dr. F. Cresswell recommends a modification of Fehling's solution for detecting and estimating sugar in urine. He takes 35 grms. of copper sulphate, dissolves it in 200 c.c. of glycerin, and 100 c.c. of water, adds 80 grms. sodium hydrate previously dissolved in 400 c.c. of water, and boils the mixture for fifteen minutes. The liquid is made up to 1 litre with distilled water, and is then let stand until clear. This mixture is preferable to Fehling's solution, as it is very much more permanent, and is scarcely attacked by uric acid.

Dr. G. Johnson uses, instead of Esbach's reagent for albumen in urine, a solution of picric acid, 5 grains to the ounce.

Dr. G. H. Savage calls attention to the increasing abuse of chloral, a vice now spreading alike among over-worked professional men and among fashionable idlers. We may ask what is gained by the temperance movement if ether, chloral, coca, and opium are substituted for wines and malt liquors?

In a paragraph by Dr. Schröder, on the action of various anthelmintic drugs upon *Ascaris lumbricoides*, we felt somewhat shocked at seeing this creature referred to as "the insect."

CORRESPONDENCE.

CHROMIC ACID COMBUSTION.

To the Editor of the Chemical News.

Sir,—If Dr. Burghardt will read our first communication on this subject (Chemical News, vol. lii., p. 207), referred to in the second note upon which he has based his letter of criticism, he will find he has made two serious mistakes:—

First, as to the method in question. What we have proposed is an anhydrous combustion, the substance being burned by CrO_3 in contact with H_2SO_4, and the estimation of the evolved gases—in many cases a mixture of CO and CO_2—by measurement of volume. Dr. Burghardt's method (Chemical News, vol. liii., p. 271) appears to be an aqueous combustion, with a gravimetric estimation of the carbonic anhydride, assumed to be, as in this case it may be, the only gaseous product.

Second, as to priority of date of publication. We need only point out that there is a difference of some months in favour of the first named.

Regretting the necessity of trespassing on your space,—We are, &c.,

E. F. Cross and E. J. Bevan.

Laboratory, 4, New Court, Lincoln's Inn, London, January 22, 1887.

ON THE COMPOSITION OF HYDRATED SALTS.

To the Editor of the Chemical News.

Sir,—In answer to M. Maumené's enquiries (Chemical News, vol. liv., p. 33) I beg to state—

1st. That the term "ordinary," as applied by us to alum, was certainly not intended to mean "impure." The alum which I examined was re-crystallised several times, and some specimens were prepared from pure alumina and pure potash, and others from metallic aluminium.

2nd. My statement was that pure alum crystallised in the ordinary way, and not subjected to the action of any desiccating agents, contains exactly 24 H_2O, and no more. As my work on the subject was performed in 1881 I may be excused for not apologising to M. Maumené for omitting at the time to consult his note of 1886. (With reference to desiccated alum, see *Chem. Soc. Trans.*, 1886, 12.)

3rd. I most unhesitatingly deny that pure crystallised magnesium sulphate contains 6·67 H_2O only. It contains exactly 7H_2O.

4th. I have never examined calcium chloride carefully.

5th. I do not for one minute call in question the even Arcadian simplicity of "equal weights" as the basis of chemical combination, but that it is capable of explaining the composition of all compounds *without any exception*, or, as far as I know, of any compounds at all, I utterly deny.—I am, &c.,

Spencer Pickering.

NATIVE ALLOY OF IRON AND NICKEL.

To the Editor of the Chemical News.

Sir,—Noticing under the heading of "Miscellaneous" (Chemical News, vol. liv., p. 310) a paragraph upon "Native Alloy of Nickel and Iron," being an announcement by the President of the Geological Society on December 1st, and communicated by Prof. Ulrich, of Dunedin, N.Z., stating that the sands of certain rivers flowing from Olivine Enstatite rocks, in the interior of South Island of New Zealand, contain metallic particles which proved to be an alloy of nickel and iron, please allow me to say that most rivers which run through districts abounding with eruptive rocks deposit sands containing metallic iron, as nearly all eruptive rocks contain metallic iron, and there are very few deposits of serpentine but what contain both metallic iron and nickel. Many of the gabros contain a similar compound of pure iron and nickel as that spoken of by Prof. Ulrich. I have tried the basalt of Ireland, Scotland, and Rouley Regis; hornblendes from Cornwall, Germany, Scotland, Norway, and America; and granite from many places,—and all contain metallic iron. Serpentine from the Lizard, Cornwall, Island of Lewis, Canada, Scotland, Germany, and Norway, and the Ural, I have found to contain the compound of metallic nickel and iron, together with oxide of nickel, sometimes as much as 0·6 to 0·7 per cent. I have found many of the Norwegian Swedish gabros contain metallic nickel combined with iron, not as sulphides, but as magnetic particles of malleable iron and nickel.

As regards the prevalence of native iron in eruptive rocks, anyone may convince himself of this by grinding a portion down in an earthenware mortar, and carefully washing (say) 100 grains of material down to about 10 grains, and then completing the levigation in an agate mortar by grinding very fine and carefully washing: the last few particles that remain in the mortar will be found to be metallic iron, or an alloy of iron and nickel when from serpentine, or from gabros when from nickeliferous district.—I am, &c.,

A. Merry.

Bryn, Heulog, Swansea, January 20, 1887.

ANALYSIS OF HOOFS AND HORNS.

To the Editor of the Chemical News.

Sir,—In reference to the "Note on the Analysis of Hoofs and Horns" (Chemical News, vol. liv., p. 314) I should think Kjeldahl's method would be found far superior to the soda-lime method for determining nitrogen in hoofs, horns, shoddy, and such like nitrogenous substances.

By the use of Kjeldahl's method all the nitrogen would be recovered as ammonia, and consequently errors such as that described in the last paragraph of the note referred to would be avoided.—I am, &c.,

D. A. L.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Vol. xlvi., No. 12, December 20, 1886.

Pyrometric Measurements at High Temperatures.—MM. Ch. Lauth and G. Vogt.—After criticising the existing pyrometers, including the circulating water-pyrometer devised by one of them, they propose to place in different parts of the furnace in question substances capable of melting and to observe the moment at which they enter into fusion. If the melting-points of these substances are known, we have precise information as to the temperature reached at this moment. These indicators, which the authors call "fusible watches," were made at first of alloys of silver and gold for temperatures below 1075°, and of gold and platinum for greater heats. Alloys of silver and gold give exact and constant results, but those of gold and platinum are trustworthy only if they contain proportions of platinum not exceeding 15 per cent (melting-point 1160°). If the proportion of platinum is greater, a portion of the alloy rich in gold melts out first, whilst the remainder, richer in platinum, only melts at a higher temperature, thus rendering the indications doubtful. This circumstance, joined to the costliness of the alloys, led the authors to form their "fusible watches" of different materials. They form No. 1 watch of a mixture of pegmatite 51 per cent, sand 14, chalk 20, melted borax 15. They make a mixture of pegmatite 70 and chalk 30 per cent, and from this they make up their remaining "watches" as follows:—No. 2 is formed of No. 1 15 parts and 85 of the above mixture; No. 3, mixture 80 and hydrated silicate of alumina 20; No. 4, mixture 60 and hydrated aluminium silicate 40.

The Combination-Heats of the Monobasic or Homologous Acids.—MM. H. Gal and E. Werner.—Already noticed.

Determination of the Neutralisation-Heats of the Malonic, Tartronic, and Malic Acids. Remarks on the Neutralisation-Heats of the Homologues of Oxalic Acid and of the corresponding Hydroxylic Acids.—MM. H. Gal and E. Werner.—Already noticed.

Composition of the Alkaline Permanganates.—F. M. Raoult.—It results that the true formula of permanganic acid is $HMnO_4$, so that the molecule of this acid contains really an odd number of atomicities.

A Rapid Method of Separating Gold and Platinum from Antimony, Arsenic, and Tin.—Ph. J. Dirvell.—Inserted in full.

Water of Combination of the Alums.—M. Maumené.—Already noticed.

Chlaurose-Phosphorous Ethers.—L. Lindet.—The ethylic and methylic ethers have both analogous chemical properties. The former is scarcely attacked by light; the methylic ether is more so, and is slightly blackened in the course of a few days, with reduction of gold. Both are stable as regards heat, the ethylic ether being able to bear the temperature of the water-bath for some time. Above 100° it is decomposed. Both are soluble in alcohol, ether, benzene, and are recovered unchanged on the evaporation of the solvent. Both are insoluble in water, which does not exert any marked reductive action upon them.

Successive Separation of Copper, Cadmium, Zinc, and of Nickel or Cobalt, Iron, and Manganese.—M. Carnot.—Already inserted.

Journal de Pharmacie et de Chemie.
Fifth Series, Vol. xiv., No. 10, November 15, 1886.

Is Linseed Meal a Medicine?—P. Carles.—From this purely pharmaceutical paper we merely extract the remark that the flesh of animals, and especially of poultry, fed upon linseed cake is indigestible, and of a bad flavour.

Coloured Reaction produced by Sulphuric Acid and Morphine.—MM. Gasselin and Lévy.—A note recently reproduced by the *Journal de Pharmacie* indicates, as characteristic reactions of morphine, the colourations given by the successive action of sulphuric acid in presence of potassium arseniate, of water, and of ether or chloroform. M. Jorissen, of Liège, indicated, in 1879, an analogous colouration, produced under the influence of sulphuric acid alone, of water, and of ether or chloroform. The authors, on repeating the experiment, find that the colouration is produced as distinctly with pure sulphuric

acid as with the same acid mixed with an arseniate. Pure codeine produces the same colouration with less intensity.

Auropotassic Reagent for the Detection of Glucose.—C. Agostini.—Already noticed.

No. 11, December 1, 1886.

Report Presented on Behalf of the Chemical Section, on the Researches of M. Moissan on the Isolation of Fluorine.—M. Debray.—The substance of this report has been already given.

Remarks on the Detection and the Colorimetric Determination of Salicylic Acid.—M. Frehse.—The general process is that founded upon the reaction of ferric chloride, but certain precautions are necessary to obtain good results. The standard liquid with which the check determination is made should be recent. A second condition is always to extract the salicylic acid (contained in mixtures) by means of ether, and not to attempt its direct determination in slightly coloured liquids. The solution of ferric chloride employed must be very dilute, as a slight excess destroys the colouration. In distillation a part of the salicylic acid is carried away with the watery vapour.

Saturation of Normal Arsenic Acid by Lime-, Strontia-, and Baryta-Water.—Ch. Blarez.—Already noticed.

Separation and Determination of Albumenoid Matter in Kystic Ovarian Matters, and in Ascitic Liquids.—G. Dumonthiers.—For this paper, which is chiefly of a medical interest, we must refer to the original.

No. 12, December 15, 1886.

New Reaction of Tannin.—J. W. Moll.—As reagents for micro-chemical research the author recommends a saturated solution of copper acetate in which sections of vegetable tissues, &c., are steeped for seven to ten days. They are then transferred for a few minutes to a dilute solution of iron acetate. The sections are then washed in water.

Novel Reactions of Sugar.—H. Molisch.

New Scientific Journal.—We have received the prospectus of a new scientific journal, the *Zeitschrift für Physicalische Chemie*, which will be edited by Professor W. Ostwald, of the Riga Polytechnicum. It will be devoted to physical chemistry, stœchiometry, the doctrine of affinity, &c. Among the contributors we notice the names of Lothar Meyer, D. Mendeleeff, N. Menschutkin, Nilson and Pettersson, of Stockholm, and Thomsen, of Kopenhagen.

MEETINGS FOR THE WEEK.

MONDAY, 31st.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "The Diseases of Plants," by Dr. Thudichum.
TUESDAY, Feb. 1st.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8 "The Condition of Applied Art in England, and the Education of the Art Workman," by T. Armstrong.
—— Pathological, 8.30.
WEDNESDAY, 2nd.—Society of Arts, 8. "Sewage Irrigation," by Alfred Carpenter, M.D.
THURSDAY, 3rd.—Royal, 4.30.
—— Chemical, 8. Ballot for the Election of Fellows.
—— London Institution, 6.
—— Royal Institution, 3. "Molecular Forces," by Prof. A. W. Rücker, F.R.S.
—— Royal Society Club, 6.30.
FRIDAY, 4th.—Geologists' Association 8.
—— Royal Institution, 9. "Some Unpublished Records of the City of London," by Edwin Freshfield, LL.D.
SATURDAY 3th.—Royal Institution, 3. "Modern Composers of Classical Song—Johannes Brahms," by Carl Armbruster.

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THE CHEMICAL NEWS.

Vol. LV. No. 1419.

FERRIC CHLORIDE AS AN EXCITING AGENT FOR VOLTAIC BATTERIES.

By H. N. WARREN, R.A.

Based upon the reducing action that zinc exerts over an acidified solution of potassium bichromate is the construction of the well-known bichromate battery; and on a somewhat similar theory of reduction I have lately found an acidified solution of ferric chloride mixed with bromine to answer the purpose still more energetically, and at the same time assuming a constant action, a point which has long been desired with respect to the bichromate battery, the construction of the battery itself being almost identical with the bichromate-bottle form, but charged with a concentrated solution of ferric chloride with a layer of bromine at the bottom, the solution being slightly acidified. Thus ferric chloride being far more soluble in water than potassium bichromate in the first instance, a much stronger solution may be obtained; the bromine so acting as to continuously convert the ferrous chloride, formed by the reduction of the zinc, back to ferric chloride; and in thus doing maintaining a constant action. With respect to the power of the electrical current produced I have found it to be the most powerful yet examined, two small half-pint cells decomposing water most energetically, and three similar cells, heated to intense whiteness two inches of fine platinum wire; whilst four large size cells, charged with the same solution, gave an intense arc between two graphite points, and very perceptibly volatilised platinum; all the more oxidisable metals, as well as silver and gold, were dissipated with great brilliancy when introduced between the points; the strength of the battery is slightly impaired after three hours' action, owing to the reducing action of the zinc somewhat overcoming the oxidising effects of the bromine, but on allowing the battery to stand a short time, it fully recovers its original power. The bromine being once consumed may be again liberated by the introduction of a small quantity of bleaching-powder, thus rendering the battery in every respect more constant, more powerful, and at the same time less costly in its construction than any other form of voltaic battery.

EXAMINATION OF BUTTER COLOURS.

By H. B. CORNWALL.

Several of our States have forbidden the addition of colouring-matter to butter substitutes in imitation of the yellow colour of genuine butter, so that our chemists frequently have to make tests for such added colours.

Not one of the published methods tried by the writer gave much satisfaction; some failed to extract colouring-matters known to have been added, others gave emulsions which were entirely useless for examination, and the writer consequently tried to find some better method.

The following gave perfect satisfaction so far as regarded the separation of annatto, which is the chief ingredient of every commercial butter colour met with by the writer:—

About 5 grms. of the warm filtered fat are dissolved in about 50 c.c. of ordinary ether, in a wide tube, and the solution is vigorously shaken for ten to fifteen seconds, with 12 to 15 c.c. of a very dilute solution of caustic potash or soda in water, only alkaline enough to give a distinct reaction with turmeric paper, and to remain alkaline after separating from the ethereal fat solution. The corked tube is set aside, and in a few hours, at most, the greater part of the aqueous solution, now coloured more or less yellow by the annatto, can be drawn from beneath the ether with a pipette, or by a stopcock below, in a sufficiently clear state to be evaporated to dryness and tested in the usual way with a drop of concentrated sulphuric acid.

Sometimes it is well to further purify the aqueous solution by shaking it with some fresh ether before evaporating it, and any fat globules that may float on its surface during evaporation should be removed by touching them with a slip of filter-paper; but the solution should not be filtered, because the filter-paper may retain much of the colouring-matter.

The dry, yellow, or slightly orange residue turns blue or violet-blue with sulphuric acid, then quickly green, and finally brownish or somewhat violet (this final change being variable, according to the purity of the extract).

Saffron can be extracted in the same way; it differs from annatto very decidedly, the most important difference being in the absence of the green colouration.

Genuine butter, free from foreign colouring-matter, imparts at most a very pale yellow colour to the alkaline solution; but it is important to note that a mere green colouration of the dry residue on addition of sulphuric acid is not a certain indication of annatto (as some books state), because the writer has thus obtained from genuine butter, free from foreign colouring-matter, a dirty green colouration, but not preceded by any blue or violet-blue tint.

Blank tests should be made with the ether; but it is easy to obtain ether that leaves nothing to be desired as to purity.

Turmeric is easily identified by the brownish to reddish stratum that forms between the ethereal fat solution and the alkaline solution before they are intimately mixed. It may be even better recognised by carefully bringing a feebly alkaline solution of ammonia in alcohol beneath the ethereal fat solution, with a pipette, and gently agitating the two, so as to mix them partially.

John C. Green School of Science,
Princeton, New Jersey.

EXAMINATION OF A SPECIMEN OF QUARTZITE.

By PHILIP HOLLAND,
Public Analyst for Southport.

I am indebted to Mr. Parson Smith, of Shrewsbury, for the sample. The stone is quarried at Nill's Hill, Pontesbury, and is sold as paving setts and for road-mending. My sample consisted of a pound or more of small chips, which were for the most part light coloured, with here and there a slightly darker one. When examined with a pocket lens the stone appears made up of irregular rounded grains, some bright and translucent, others milky, many dark and opaque.

Quartzite is considered to be an altered sandstone, the alteration consisting in the cementation of the somewhat loose quartz grains of the sedimentary rock by transfusion of siliceous matter in solution. Heat and pressure, also, will doubtless have contributed not a little to bring about the change in physical character.

A friend, Mr. E. Dickson, to whom I showed the stone, selected a piece from which a section was afterwards cut for microscopical examination. He says of the rock:—"It is a compact felspathic quartzite. When examined microscopically there are evidences of a third mineral, but owing to the decomposed condition of the felspar and this mineral in the specimen examined it is almost im-

possible to determine them accurately. The felspar is, however, most probably orthoclase. The section shows presence of iron. Under a ¼ objective both the quartz and the felspar, but more especially the former, are seen to contain cavities, some being relatively of large size. The quartz grains clearly indicate the clastic character of the rock. They also exhibit secondary enlargement, due to infiltration of silica; the interstices of the rock have in this way become filled with silica not in optical continuity with that of the original grains."

The object is seen to great advantage under a binocular with an inch power, the granules many of them appearing to shade off into adjoining ones, merging their identity in that of their neighbours. When viewed as above a large number of the grains are seen to be speckled throughout with finely divided dark matter. As regards the cavities I am able to confirm Mr. Dickson's observation. A photo-micrograph was taken of the section, which is interesting to study. The accompanying illustration is from a pencil-sketch with the camera lucida, and has a magnification of 55 diameters.

Pontesbury Quartzite. (Magnification 55 linear).

A chemical analysis of a uniform sample of the quartzite was made, in which I employed both the fusion and HF methods of treatment. The following numbers were obtained:—

SiO_2	94·850
Al_2O_3	2·380
Fe_2O_3	0·619
K_2O	0·668
Na_2O	0·712
Carbon	0·070
Combined water ..	0·627
	99·926

The combined water was found by direct weighing, and is the mean of two estimations.

Four were made of the alkalies; two by L. Smith's plan, and two by use of HF in solution.

It was when treating the quartzite with a re-distilled solution of HF that the carbon was first detected. The fact of the insoluble matter being chiefly carbon was established later on. In some of the slightly darker fragments of the stone—which I should state were washed with a clean brush and water only, and then dried—the carbon amounted to 0·13 per cent.

Is this carbon in the quartzite traceable to organic remains in the sedimentary rock before this rock was metamorphosed into quartzite?

The finding of carbon in the latter seems to point to the existence of organised forms in Cambrian or pre-Cambrian times, and supports the evidence of the supposed fucoid markings and worm-tracks found in the quarry whence this stone was obtained.

DETECTION OF BLOOD-SPOTS IN PRESENCE OF IRON-RUST.

By E. DANNENBERG.

Generally speaking the detection of blood in chemico-legal investigations has not been difficult since the discovery of the crystals of hæmine. The case is different if blood-spots fall upon rusty iron, in which case no hæmine crystals can be produced, since the blood becomes insoluble in consequence of its combination with ferric oxide. Setting out with the idea of decomposing the compound of blood and iron by means of alkaline sulphides, the author obtained in a preliminary experiment, from a mixture of about equal parts of blood, water, and ammonium sulphide (according to Erdmann's process), along with the ordinary hæmine crystals, a number of others hitherto unknown. They were very elegant, extended, rhombic tables, brown, but with a clear colourless portion or stripe in the direction of the minor diameter of the rhombus. Some of them were rhomboidal or had blunted ends, but there was always the clear stripe in the middle.

These "hæmadine" crystals are obtained with such certainty from blood-stained rust that in thirty experiments, with strong and slight spots, the author was always successful. He proceeds as follows:—He lets fall upon the suspected spot, according to its size, two, four, or six drops of a 10 per cent solution of caustic potash, and lets

it soak for an hour. The spot is then loosened with a knife-point, and rinsed into a small porcelain capsule, in which it is repeatedly washed by decantation, removing the water at last almost entirely by inclining the capsule. The residue is moistened with a few drops of ammonium sulphide, rubbing the mass up with a pestle, and applying a gentle heat. In about ten minutes it is diluted with a little water and filtered. The first few drops, if treated according to Erdmann's process, yield the new hæmadine crystals.—*Chemiker Zeitung.*

(Dr. Amtha maintains that these crystals are merely sulphur, and that they can be obtained in the absence of blood.)

FURTHER RESEARCHES ON COMPLEX INORGANIC ACIDS.

By DR. WOLCOTT GIBBS.

You will doubtless remember the very interesting and curious results obtained many years since by Schützenberger by the action of phosphoric pentachloride upon spongy platinum. We have simply $Pt+PCl_5=PtCl_2.PCl_3$, the compound by the action of water giving the corresponding acid $PtCl_2.P(OH)_3$. A second and analogous compound chloride has the formula $PtCl_2.2PCl_3$, and this yields the acid $P_2.PtCl_2.(OH)_6$. A third acid has the formula $P_2.PtCl_2.(OH)_5$, and a fourth is represented by $P_2O_2.PtCl.(OH)_3$. These compounds have attracted very little attention, perhaps on account of the neglect and contempt into which inorganic chemistry has fallen of late years. Schützenberger does not appear to have attempted to generalise his results. I have endeavoured to show, in a paper read before the National Academy of Science, that in Schützenberger's acids platinous chloride simply replaces an atom of oxygen, and that, by appropriate methods, we ought to be able to perform the inverse substitution and obtain three new acids of phosphorus which would have respectively the formulæ $P_2O(OH)_6$, $P_2O(OH)_5$ or perhaps $P_4O_2(OH)_{12}$, and $P_4O_7(OH)_6$, since $2PtCl'''=3O$. Of course the first acid mentioned above, $P.PtCl_2.(OH)_3$, is, on this view, orthophosphoric acid, in which $PtCl_2$ replaces one atom of oxygen. I have now succeeded in generalising these results in what seems to me an interesting manner. In the first place I have discovered compound acids analogous to chlorplatinorthophosphoric acid which contain respectively palladium, iridium, ruthenium, and osmium in place of platinum. Want of material has prevented me from experimenting with rhodium also, but it can hardly be doubted that it forms similar compounds. In the next place I find that platinous chloride may be replaced by platinous oxide or bromide, and the same appears to be true for other metals of the platinum group. A still further generalisation consists in replacing phosphorus by arsenic and antimony, which is easily effected. It is to be expected that vanadium will yield similar compounds, but here again want of material has prevented the actual experiment up to the present time. The following formulæ, which are, I believe, to be depended on, will serve to illustrate my results:—

$$As_2O_3.3[As_2O_3.2PtO]5(NH_4)_2O+7Aq.$$
$$[As_2O_3.2PtCl_2]K_2O.2H_2O.$$

As I have written it, the first compound might be called an arsenoso-oxyplatin-arsenate, and the second a chlorplatin-arsenate. When these compounds are digested or boiled with acid tungstates and molybdates, higher complex acids are obtained, which I am now studying. One tungsten compound appears to have the formula—

$$24WO_3.As_2O_3.3[As_2O_3.2PtCl_2]12Pt(NH_3)_4O+60Aq.$$

Another, the formula—

$$22WO.3As_2O_3.3[As_2O_3.2PtO]6Pt(NH_3)_4O+40Aq.$$

A beautiful pale green molybdenum compound has the formula—

$$12MoO_3.As_2O_3[As_2O_3.2PtO]2Pt(NH_3)_4O+27Aq.$$

All these compounds contain the oxide of platinoditetramine, $Pt(NH_3)_4O$, as a base. The formulæ given, however, are only preliminary, and may hereafter prove reducible to simpler expressions. The salts were obtained by digesting or boiling the green salt of Magnus, $Pt(NH_3)_4Cl_2+PtCl_2$, with arsenoso-tungstates and arsenoso-molybdates. Analogous series appear to be formed when arsenoso-phospho-tungstates and arsenoso-phospho-molybdates are digested or boiled with platinous chlorine or with the tetramine salt. Now, replace platinum by other metals of the same group, and arsenic by antimony or phosphorus, perhaps also by vanadium, and you will have some idea of the extent of the new field of work in which I am now labouring as fast as my limited means and resources will permit.—*American Chemical Journal*, vol. viii., No. 4.

ANALYSES OF COMMERCIAL FERTILISERS.*

OFFICIAL METHODS OF THE ASSOCIATION OF AGRICULTURAL CHEMISTS FOR 1886-7.

(Continued from p. 39.)

METHOD FOR DETERMINING PHOSPHORIC ACID AND MOISTURE.

(1) *Preparation of Sample.*—The sample should be well intermixed and properly prepared, so that separate portions shall accurately represent the substance under examination, without loss or gain of moisture.

(2) *Determination of Moisture.*—(*a.*) In potash salts, nitrate of soda, and sulphate of ammonia heat 1 to 5 grms. at 130° C. till the weight is constant, and reckon water from the loss. (*b.*) In all other fertilisers heat 2 grms., or, if the sample is too coarse to secure uniform lots of 2 grms. each, 5 grms. for five hours at 100° in a steam-bath.

(3) *Water-soluble Phosphoric Acid.*—Bring 2 grms. on a filter, add a little water, let it run out before adding more water, and repeat this treatment cautiously until no phosphate is likely to precipitate in the filter. If the washings show turbidity after passing the filter, clear up with acid. When the substance is nearly washed in this manner it is transferred to a mortar and rubbed with a rubber-tipped pestle to a homogeneous paste (but not further pulverised), then returned to the filter, and washed with water until the filtrate measures not less than 250 c.c. Mix the washings. Take an aliquot (usually corresponding to ½ or ½ grm. of the substance) and determine phosphoric acid, as under "Total Phosphoric Acid."

(4) *Citrate-insoluble Phosphoric Acid.*—Wash the residue of the treatment with water into a 150 c.c. flask with 100 c.c. of strictly neutral ammonium citrate solution of 1·09 density, shred and add the filter-paper, cork the flask securely, place in a water-bath with constant temperature of 65° C., and digest for thirty minutes at this temperature with frequent shaking; filter the warm solution quickly, and wash with water of ordinary temperature. Transfer the filter and its contents to a capsule, ignite until the organic matter is destroyed, treat with 10 to 15 c.c. of concentrated hydrochloric acid, digest over a low flame until the phosphate is dissolved, dilute to 200 c.c., mix, pass through a dry filter; take an aliquot, and determine phosphoric acid as under "Total."

In case a determination of citrate-insoluble phosphoric acid is required in non-acidulated goods, it is to be made by treating 2 grms. of the phosphatic material without previous washing with water, precisely in the way above

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C., August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

described, except that in case the substance contains much animal matter (bone, fish, &c.) the residue insoluble in ammonium citrate is to be digested with HCl and $KClO_3$, as described below.

(5) *Total Phosphoric Acid.*—Weigh 2 grms. into a flask or beaker, add 30 c.c. concentrated hydrochloric acid, heat and add cautiously and in small quantities at a time about 0·5 grm. finely powdered potassium chlorate. Digest at a gentle heat until all phosphates are dissolved and all organic matter destroyed, dilute to 200 c.c., mix, pass through a dry filter; take 50 c.c. of filtrate, neutralise with ammonia; for every decigrm. of P_2O_5 that is present 50 c.c. of molybdic solution. Digest at about 65° C. for one hour, filter, and wash with ammonium nitrate solution. (Test the filtrate by renewed digestion and addition of more molybdic solution. Dissolve the precipitate on the filter with ammonia and hot water, and wash into a beaker to a bulk of not more than 100 c.c. Nearly neutralise with hydrochloric acid, cool, and add magnesia mixture from a burette: add slowly (one drop per second), stirring vigorously. After fifteen minutes add 30 c.c. of ammonia solution of density 0·95. Let stand several hours (two hours is usually enough). Filter, wash with dilute ammonia, ignite intensely for ten minutes, and weigh.

(6) *Citrate-soluble Phosphoric Acid.*—The sum of the water-soluble and citrate-insoluble subtracted from the total gives the citrate-soluble.

Preparation of Reagents.

(1) *To Prepare Ammonium Citrate Solution.*—Mix 370 grms. of commercial citric acid with 1500 c.c. of water; nearly neutralise with crushed commercial carbonate of ammonia, heat to expel the carbonic acid, cool, add ammonia until exactly neutral (testing by saturated alcoholic solution of coralline), and bring to volume of 2 litres. Test the gravity, which should be 1·09 at 20°, before using.

(2) *To Prepare Molybdic Solution.*—Dissolve 100 grms. of molybdic acid in 400 grms. or 417 c.c. of ammonia of sp. gr. 0·96, and pour the solution thus obtained into 1500 grms. or 1250 c.c. of nitric acid of sp. gr. 1·20. Keep the mixture in a warm place for several days, or until a portion heated to 40° C. deposits no yellow precipitate of ammonium phospho-molybdate. Decant the solution from any sediment, and preserve in glass-stoppered vessels.

(3) *To Prepare Ammonium Nitrate Solution.*—Dissolve 200 grms. of commercial ammonium nitrate in water, and bring to a volume of 2 litres.

(4) *To Prepare Magnesia Mixture.*—Dissolve 22 grms. of recently-ignited calcined magnesia in dilute hydrochloric acid, avoiding excess of the latter. Add a little calcined magnesia in excess, and boil a few minutes to precipitate iron, alumina, and phosphoric acid; filter; add 280 grms. of ammonium chloride, 700 c.c. of ammonia of sp. gr. 0·96, and water enough to make the volume of 2 litres. Instead of the solution of 22 grms. of calcined magnesia, 110 grms. of crystallised magnesium chloride ($MgCl_2,6H_2O$) may be used.

(5) *Dilute Ammonia for Washing.*—One volume ammonia of sp. gr. 0·96 mixed with 3 volumes of water, or usually 1 volume of concentrated ammonia with 6 vols. of water.

Methods for Determining Potash.

In case the potash is contained in organic compounds like tobacco stems, cotton-seed hulls, &c., it is to be saturated with strong sulphuric acid and ignited in a muffle to destroy organic matter. Pulverise the fertiliser (200 or 300 grms.) in a mortar; take 10 grms., boil for ten minutes with 200 c.c. water, and after cooling, and without filtering, make up to 1000 c.c., and filter through a dry paper. If the sample have 10 to 15 per cent K_2O (kainite), take 50 c.c. of the filtrate; if from 2 to 3 per cent K_2O (ordinary potash fertilisers), take 100 c.c. of the filtrate. In each case make the volume up to 150 c.c., heat to 100°, and add, drop by drop, with constant stirring, slight excess of barium chloride; without filtering, in the same manner, add barium hydrate in slight excess. Heat, filter, and wash until precipitate is free of chlorides. Add to filtrate 1 c.c. strong ammonium hydrate, and then a saturated solution of ammonium carbonate until excess of barium is precipitated. Heat. Add now, in fine powder, 0·5 grm. pure oxalic acid, or 0·75 grm. ammonium oxalate. Filter, wash free of chlorides, evaporate filtrate to dryness in a platinum dish, and, holding dish with crucible tongs, ignite carefully over the free flame below red heat until all volatile matter is driven off.

The residue is now digested with hot water, filtered through a small filter, and washed with successive small portions of water until the filtrate amounts to 30 c.c. or more. To this filtrate, after adding two drops of strong hydrochloric acid, is added, in a porcelain dish, 5 to 10 c.c. of a solution of 10 grms. of platinic chloride in 100 c.c. of water. The mixture is now evaporated on the water-bath to a thick syrup, or further, treated with strong alcohol washed by decantation, collected in a Gooch crucible or other form of filter, washed with strong alcohol, afterwards with 5 c.c. ether, dried for thirty minutes at 100°, and weighed.

It is recommended that if there is an appearance of white foreign matter in the double salt it should be washed with 10 c.c. of a half-concentrated solution of NH_4Cl, which has been saturated by shaking with K_2PtCl_6, rejecting the first portion running through and using 10 c.c. of fresh solution, returning the same portion five or six times upon the salt, and finally using another portion, and then alcohol and ether, after the method recommended by Gladding.

As an alternative the entire method of Lindo, as modified by Gladding, may be used in the determination of potash when, in the opinion of the analyst, it is found satisfactory.

The use of the factor 0·3056 for converting K_2PtCl_6 to KCl and 0·19308 for converting to K_2O are continued.

Method of Lindo as modified by Gladding.

(1) *Superphosphates.*—Boil 10 grms. of the fertiliser with 300 c.c. of water for ten minutes. Cool the solution, add ammonia in slight excess, thus precipitating all phosphate of lime, oxide of iron, alumina, &c.; make up to 500 c.c., mix thoroughly, and filter through a dry filter; take 50 c.c., corresponding to 1 grm., evaporate nearly to dryness, add 1 c.c. of dilute H_2SO_4 (1 to 1), and evaporate to dryness and ignite to whiteness. As all the potash is in form of sulphate, no loss need be apprehended by volatilisation of potash, and a full red heat must be used until the residue is perfectly white. This residue is dissolved in hot water plus a few drops of HCl; 5 c.c. of a solution of pure NaCl (containing 20 grms. NaCl to the litre) and an excess of platinum solution (4 c.c.) are now added, and the whole evaporated as usual. The precipitate is washed thoroughly with alcohol by decantation and on filter, as usual. The washing should be continued even after the filtrate is colourless. Ten c.c. of the NH_4Cl solution prepared as above are now run through the filter. These 10 c.c. will contain the bulk of the impurities, and are thrown away. A fresh portion of 10 c.c. NH_4Cl is now run through the filter several times (5 or 6). The filter is then washed thoroughly with pure alcohol, dried, and weighed as usual. The platinum solution used contains 1 grm. metallic platinum in every 10 c.c.

(2) *Muriates of Potash.*—In the analysis of these salts an aliquot portion, containing 0·500 grm., is evaporated with 10 c.c. platinum solution plus a few drops of HCl, and washed as before.

(3) *Sulphate of Potash, Kainite, &c.*—In the analysis of these salts an aliquot portion, containing 0·500 grm. is taken, 0·250 grm. of NaCl added, plus a few drops of HCl, and the whole evaporated with 15 c.c. platinum solution. In this case special care must be taken, in the

washing with alcohol, to remove all the double chloride of platinum and sodium. The washing should be continued for some time after the filtrate is colourless. Twenty-five c.c. of the NH_4Cl solution are employed instead of 10 c.c., and the second 25 c.c. poured through at least six times to remove all sulphates and chlorides. Wash finally with alcohol, dry, and weigh as usual.

To prepare the washing solution of NH_4Cl, place in a bottle 500 c.c. H_2O, 100 grms. of NH_4Cl; shake till dissolved. Now pulverise 5 or 10 grms. of K_2PtCl_6, put in the bottle, and shake at intervals for six or eight hours; let settle over night; then filter off liquid into a second bottle. The first bottle is then ready for a preparation of a fresh supply when needed.

Determination of Nitrogen by the Absolute or Cupric Oxide Method.

The apparatus and reagents needed are as follows:—

Apparatus.

Combustion tube of best hard Bohemian glass, about 26 inches long and ½ inch internal diameter.

Azotometer of at least 100 c.c. capacity accurately calibrated.

Sprengel mercury air-pump.

Small paper scoop, easily made from stiff writing-paper.

Reagents.

Cupric Oxide (coarse).—Wire form; to be ignited and cooled before using.

Fine Cupric Oxide.—Prepared by pounding ordinary cupric oxide in mortar.

Metallic Copper.—Granulated copper or fine copper gauze reduced and cooled in stream of hydrogen.

Sodium Bicarbonate.—Free from organic matter.

Caustic Potash Solution.—Dissolve commercial stick potash in less than its weight of water, so that crystals are deposited on cooling. When absorption of carbonic acid ceases to be prompt, solution must be discarded.

Loading Tube.

Of ordinary commercial fertilisers take 1 to 2 grms. for analysis. In the case of highly nitrogenous substances the amount to be taken must be regulated by the amount of nitrogen estimated to be present. Fill tube as follows: (1) About 2 inches of coarse cupric oxide. (2) Place on the small paper scoop enough of the fine cupric oxide to fill, after having been mixed with the substance to be analysed, about 4 inches of the tube; pour on this the substance, rinsing watch-glass with a little of the fine oxide, and mix thoroughly with spatula; pour into tube, rinsing the scoop with a little fine oxide. (3) About 12 inches of coarse cupric oxide. (4) About 3 inches of metallic copper. (5) About 2½ inches of coarse cupric oxide (anterior layer). (6) Small plug of asbestos. (7) Eight-tenths to 1 grm. of sodium bicarbonate. (8) Large loose plug of asbestos; place tube in furnace, leaving about 1 inch of it projecting; connect with pump by rubber stopper smeared with glycerin, taking care to make connection perfectly tight.

Operation.

Exhaust air from tube by means of pump. When a vacuum has been obtained allow flow of mercury to continue; light gas under that part of tube containing metallic copper, anterior layer of cupric oxide (see 5th above), and bicarbonate of soda. As soon as vacuum is destroyed and apparatus filled with carbonic acid gas, shut off the flow of mercury, and at once introduce the delivery tube of the pump into the receiving arm of the azotometer and just below the surface of the mercury seal of the azotometer, so that the escaping bubbles will pass into the air and not into the azotometer, thus avoiding the useless saturation of the caustic potash solution.

When the flow of carbonic acid has very nearly or completely ceased, pass the delivery tube down into the receiving arm so that the bubbles will escape into the azotometer. Light the jets under the 12-inch layer of oxide, heat gently for a few moments to drive out any moisture that may be present, and bring to red heat. Heat gradually mixture of substance and oxide, lighting one jet a time. Avoid too rapid evolution of bubbles, which should be allowed to escape at the rate of about one per second, or a little faster.

When the jets under mixture have all been turned on, light jets under layer of oxide at end of tube. When evolution of gas has ceased, turn out all the lights except those under the metallic copper and anterior layer of oxide, and allow to cool for a few moments. Exhaust with pump, and remove azotometer before flow of mercury is stopped. Break connection of tube with pump, stop flow of mercury, and extinguish lights. Allow azotometer to stand for at least an hour, or cool with stream of water until permanent volume and temperature are reached.

Adjust accurately the level of the KOH solution in bulb to that in azotometer,; note volume of gas, temperature, and height of barometer; make calculations as usual. The labour of calculation may be much diminished by the use of the tables prepared by Messrs. Battle and Dancy, of the North Carolina Experiment Station (Raleigh, N.C.).

The above details are, with some modifications, those given in the Report of the Connecticut Station for 1879 (p. 124), which may be consulted for details of apparatus, should such details be desired.

(To be continued.)

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending December 31st, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To Colonel Sir Francis Bolton, *Water Examiner, Metropolis Water Act*, 1871.

London, January 7th, 1887.

Sir,—We submit herewith the results of our analyses of the 165 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from December 1st to December 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Altogether, the December supply of water to the Metropolis compares, in some respects, a little unfavourably with that furnished, with such marked invariability of character, for now many months past. The increase in the proportion of organic matter present in the water, as determined alike by the combustion process and the oxygen-absorption process, is, however, quite insignificant; the mean amount of organic carbon, for instance,

in the Thames-derived supply, being 0·170 part in 100,000 parts of the water, as against a mean of 0·167 part in November, and a mean of 0·137 part in the preceding four months. But, as shown in Table II., the supplies furnished by two of the seven companies during the latter half of the month, were occasionally not free from turbidity,—no single instance of even slight turbidity having been met with among the 910 samples examined in the course of the preceding five months; neither was the water, during the latter part of the month, so uniformly free from other than a preponderating blue tint of colour.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

ON THE ANALYSIS OF OPIUM.

By CHARLES M. STILLWELL, M.A.

(Concluded from p. 43).

Filtering off the Aqueous Solution of Morphia.—Filter off the solution into a graduated cylinder, and wash the filter and residue with water applied from a wash-bottle until the filtrate measures about 120 c.c.; set this strong solution aside, and return the residue to the bottle or beaker by means of a small spatula; add 30 c.c. of water, and mix or shake well, and filter this solution through the same filter. Again return the residue and treat with 20 c.c. of water and filter, and finally repeat the treatment with 20 c.c. more. By the use of the rubber-tipped rod and a beaker it is possible to so press out the water from the insoluble residue that the above treatment will exhaust 10 grms. of any opium. The water is much more thoroughly obtained from the residue than by using several more washings without pressure. It is best to let the several washings stand on the residue for ten minutes or so before transferring to the filter. These washings are received in a beaker, and are the first portion to be evaporated.

Evaporation of the Aqueous Solution of Morphia.—The second portion of the solution, the washings, measuring about 70 c.c., is placed in a porcelain capsule of 6 to 8 inches diameter, and evaporated over a water-bath at a heat below boiling. By using a broad shallow dish this evaporation takes little time, and the danger of injury to the alkaloid is reduced to a minimum. Evaporate to about 25 c.c. and then add the first portion of the solution, washing out the cylider with a little water from the wash-bottle, and evaporate the whole to about 25 c.c. Cool the capsule and contents and add 5 c.c. of alcohol (sp. gr. 0·820), and stir until a uniform solution is obtained. If a precipitate is obtained, as sometimes happens, it is not necessary to filter, as this precipitate is removed in a subsequent treatment, and is not reckoned as morphia.

Transferring to the Crystallising Flask.—Pour the solution into an Erlenmeyer flask fitted with a good velvet cork, using a flask of about 2 inches diameter at the bottom and 5 inches high, and wash the capsule with about 5 to 10 c.c. of water from the wash-bottle. I find that the quantities of water for washing and for the precipitation of the morphia may be slightly greater than those recommended by Dr. Squibb, without injury to the analysis. Add 5 c.c. more of alcohol, and mix the liquids thoroughly by rotating the flask, and not by an up and down movement. Then add 30 c.c. ether and again mix well by rotating.

"This shaking together first of the watery solution and alcohol causes the alcohol to combine with the water before the ether is added. The ether then added, the second shaking saturates the watery solution and combined alcohol with ether, and then the mixture is ready for the precipitation of the alkaloid under the most favourable conditions."*

Precipitation of the Morphia.—Add 40 c.c. of ammonia solution of 10 per cent (sp. gr. 0·960), wet the cork with ether, and insert at once into the flask. Shake the flask *strongly* with an up and down motion until the crystals begin to separate. This will occur in a moment or two if everything has been properly carried out. Then set the flask aside for twelve hours, or over night, to complete the crystallisation. By this vigorous shaking the crystals are obtained in a fine granular condition, easily washed and separated from the flask.

Filtering off the Morphia.—"Pour off the ethereal stratum from the flask as closely as possible on to a tared filter of about 10 c.=4 inches in diameter, well wetted with ether. Add 20 c.c. of ether to the contents of the flask, rinse round without shaking, and again pour off the ethereal stratum as closely as possible on to the filter, keeping the funnel covered. When the ethereal solution is nearly all through, wash down the edges and sides of the filter with 5 c.c. of ether, and allow the filter to drain with the cover off. Then pour on the remaining contents of the flask, and cover the funnel. When the liquid has nearly all passed through, rinse the flask twice with 5 c.c. of water each time, pouring the rinsings with all the crystals that can be loosened on to the filter, and dry the flask in an inverted or horizontal position, and when thoroughly dry, weigh it. Wash the filter and crystals with 10 c.c. of water applied drop by drop to the edges of the filter. When drained, remove the filter and contents from the funnel, close the edges of the paper together, and compress it gently between many folds of bibulous paper. Then dry it at 100° C., and weigh it. Remove the crystals of morphia from the filter, brush it off, and re-weigh it to get the tare to be subtracted. The remainder, added to the weight of the crystals in the flask, will give the total yield of morphia in clean, distinct, small, light brown crystals.

"Take a small portion of these crystals, rub them into very fine powder, and weigh off 0·1 grm. Put this in a large test-tube fitted with a good cork, and add 10 c.c. of officinal lime water. Shake occasionally, when the whole of the powder should dissolve. (Absence of Narcotine: Flückiger.)

" . . . This process, according to the skill and care with which it is managed, will give uniform results to within two or three-tenths of a per cent. Adulterated opiums are much more difficult to assay, and yield crystals which are always darker and less clean, and, therefore, the results are almost always too high. Poor opiums, on the other hand, are very easy to assay, and usually give very light-coloured clean morphia. The results here are liable to be too low, because, when the quantity of morphia is small, the alcohol and ammonia used are proportionally too large, so that much morphia may be retained in the mother-liquor. Therefore, when the morphia comes out very white and in small proportion, the assay should always be repeated, evaporating the solution to 10 grms. instead of 20, and adding 5 c.c. of alcohol instead of 10, and 2·5 or 3 c.c. of ammonia instead of 4. . . .

"The above process is very easily applicable to the assay of such preparations of opium as the tincture, deodorised tincture, and compound solution. For the assay of these—

"Take of the liquid preparation 120 c.c. Evaporate at a low temperature to 10 grms., and from this point proceed exactly as in the above process, using, however, 5 c.c. of alcohol instead of 10, and 2·5 to 3 c.c. of ammonia instead of 4."†

In following out the above plan of Dr. Squibb, several difficulties are met with. The amount of ether recommended for washing is so small that in some cases where the operation of filtering proceeds with great difficulty,

* *Ephemeris*, i., 17.
† *Ibid.*, i., 17, 20.

much of the ethereal solution is evaporated from the edges of the filter-paper, leaving its contents behind, and these are not thoroughly washed out by the subsequent treatment. The amount of water, also, is too small to allow of perfect washing.

Washing Solutions.—In order to obviate these difficulties I have adopted a plan for which I am indebted to a paper published by E. F. Teschemacher, F.C.S., &c., in the Chemical News, vol. xxxv., p. 47. The first solution, which he calls "*Morphiated Spirit*," is made by mixing one part of ammonia solution, sp. gr. 0·880, with twenty parts of alcohol, and digesting in this mixture, for several days, a large excess of morphia. The clear solution will contain 0·33 per cent of morphia. The second solution, called "*Morphiated Water*," is water saturated by long shaking with morphia. The filtered solution contains 0·04 per cent morphia.

By washing with these solutions the extractive matter is completely removed from the filter-paper and crystals of morphia. I prefer to use balanced filter-papers of 4½ inches diameter. The solution is run through one of these, and, by means of the thorough washing with the solutions above described, the two papers are left, at the end of the operation, ready for weighing against each other as at first. I pour off the ethereal stratum through the filter as above described, and then wash several times with 10 c.c. of ether, rinsing the flask around without shaking, and letting settle for a few minutes. Even if a small amount of the ethereal residue is left upon the paper by evaporation, it is immatetial, as in the subsequent treatment this is removed. A small syphon is advantageously used to draw off the ethereal solution from the Erlenmeyer flask, but if an attempt be made to syphon off the ethereal washings, it will be found that the bubbles formed in the ether collect in the tube of the syphon and prevent its action, so that it is better to wash by decantation. If some of the aqueous solution pass into the filter with the ether it is of no importance. The washing with ether is followed, first, by a thorough washing with the "*Morphiated Spirit*," thus removing all the colouring matter and resin soluble in this menstruum, and then by a thorough washing with the "*Morphiated Water*," until the filtrate comes through colourless and the paper shows by its colour that all the extractive matter is removed. By the use of the Erlenmeyer flask it is possible to remove with the rubber-tipped rod all the crystals from the flask, so that no drying and weighing of the flask is needed. After the washing with the "*Morphiated Water*" the filter is left to drain for a few minutes in the funnel, and two washings of 10 c.c. each with the "*Morphiated Spirit*" are given. This removes the bulk of the water from the paper and crystals. Let drain for a few minutes, keeping the funnel covered with a watch-glass, and then wash twice with 10 c.c. each time of ether. This will remove any narcotine which may have been left from the evaporation of the ethereal solution at the beginning of the operation. The paper and contents are thus left in a condition to be rapidly dried. Let the filter and its contents stand exposed for a few minutes, and then dry it at 100° C. and weigh. Twenty minutes or half an hour's drying is usually sufficient.

On account of the removal of the water it is possible to dry the filter and its contents in a short time at a much lower temperature than 100° C., but as it is easier to employ this heat, and no decomposition of the morphia crystals occurs, I use it. A precipitate of morphia crystals was dried for two hours at 60° C., yielding a weight of 1·306 grms. It was further dried for three hours at the same heat and then weighed 1·305 grms.; still further dried for two hours at 100° C., it became 1·301 grms.

The mother-liquor, together with the first washings of ether and "*Morphiated Spirit*," is put in a flask, 3 c.c. of ammonia added, and the corked flask is set aside over night in order to see if a further crystalline precipitate of morphia occur. If the solution is left exposed in an open beaker, amorphous flakes will settle out, consisting chiefly of resinous matter, very different from the heavy crystalline deposit of morphia.

Having thus obtained the weight of the crystalline precipitate, it is still necessary to further purify it before the final calculation is made for the per cent. The precipitate of morphia obtained by Dr. Squibb's process contains insoluble matter, resinous and other organic matters soluble in alcohol, and meconate of lime, the latter constituting about 25 per cent of the impurities present. The average amount of the impurities present in the crystals obtained by his process is 8 per cent of the weight of the crystals. The meconate of lime extracted by the acid solution of the opium is retained in solution until the addition of the ammonia, when it is precipitated with the crystals of morphia, and remains with them until the final weighing. The resinous and other organic matters, insoluble in water, but soluble in alcohol, are not thoroughly removed with the limited washing given in his process, and no provision is made for their subsequent removal. The thorough washing with "*Morphiated Spirit*" which I employ takes out these substances, and the subsequent treatment with "*Morphiated Water*" removes those insoluble in alcohol, so that the chief impurity present in the crystals of morphia obtained by my modification of the process is meconate of lime, together with some organic matters insoluble in water and alcohol.

Purification of the Precipitate.—After drying and weighing the crystals they are carefully rubbed or brushed from the filter, the latter being then placed in a funnel and preserved with its balanced paper for future use. The precipitate is treated in a small beaker with hot alcohol of 95 per cent. This dissolves all the morphia, leaving the insoluble organic matter and meconate of lime. The hot alcoholic solution is run through the filter which contained the morphia, the small portion of the crystals remaining on the paper being thus drenched with hot alcohol and the morphia dissolved. This treatment with hot alcohol is continued until all the morphia is dissolved. This extraction with alcohol may be done in a Soxhlet's apparatus, if desired. The filter is then dried with its balanced paper and the amount of residue obtained. This is subtracted from the original weight of the precipitate, and the remainder calculated into the per cent of morphia. The alcoholic solutions of morphia are placed in a bottle and left to deposit the excess of morphia, and the alcohol, saturated with morphia, is used for the preparation of the "*Morphiated Spirit*" as before described. Meconate of lime I found to be perfectly insoluble in boiling alcohol. A long treatment with this solvent failed to dissolve enough meconate of lime to give a trace of colour with ferric salts.

The composition of the morphia crystals, on which the calculation for the per cent is based, is $C_{34}H_{19}NO_6+2Aq$, containing 5·94 per cent of water of crystallisation. At 120° C. the water is expelled, and at a higher temperature the crystals become carbonised.

The following is a brief summary of my process as practised in our laboratory.

1. *Sampling.*—By taking a portion of every tenth lump in a case.

2. *Preparation of the Sample.*—By thorough mixing of the small samples obtained, either by kneading or rolling, or by drying the sample, with previous estimation of the water.

3. *Extraction of the Morphia.*—Weigh off about 10 grms., noting the exact weight taken; treat with 100 c.c. of water in a suitable vessel, macerate, let stand over night, filter, and wash, making two portions of the filtrate. Evaporate on a water-bath, first the weaker portion, about 70 c.c. of solution, then add the stronger portion, and evaporate all to 25 c.c.; add 5 c.c. of alcohol and stir untill all is dissolved.

4. *Precipitation of the Morphia.*—Transfer the solution to a suitable flask, add 5 c.c. more of alcohol, mix; then add 30 c.c. of ether, mix; then add 4 c.c. of a 10 per cent

solution of ammonia, sp. gr. 0·960. Shake violently until the crystals form, and let stand over night.

5. *Filtration of the Morphia.*—Filter off, first, the ethereal solution and wash well with ether. Then filter the aqueous solution, and wash, first with "*Morphiated Spirit*," then with "*Morphiated Water*," then with "*Morphiated Spirit*," and finally with ether. Dry at 100° C. and weigh, using balanced papers.

6. *Purification of the Morphia.*—Treat the impure precipitate with hot alcohol until all the morphia is dissolved. Wash thoroughly with hot alcohol, dry, and weigh the insoluble residue. Subtract this from the first weight of the precipitate to get the amount of morphia present.

7. *Statement of the Result.*—Give the percentage of moisture present at 100° C., and of morphia, both on a wet and dry basis, in terms of crystallised morphia, $C_{34}H_{19}NO_6+2Aq$, dried at 100° C.

Washing Solutions.

a. "*Morphiated Spirit.*"—This is made by mixing one part of ammonia solution, sp. gr. 0·880, with twenty parts of alcohol and saturating with morphia. The filtered solution contains 0·33 per cent of morphia.

b. "*Morphiated Water.*"—This is made by saturating water by long shaking with excess of morphia. The filtered solution contains 0·04 per cent of morphia.

c. Ether.—Called stronger ether, sp. gr. 0·728 at 15·5° C.—*American Chemical Journal*, vol. viii., No. 5.

A METHOD FOR THE SEPARATION OF SODIUM AND POTASSIUM FROM LITHIUM BY THE ACTION OF AMYL ALCOHOL ON THE CHLORIDES,

WITH SOME REFERENCE TO A SIMILAR SEPARATION OF THE SAME FROM MAGNESIUM AND CALCIUM.*

By F. A. GOOCH.

(Continued from page 41.)

THE point of difference between these two series of experiments is the amount of lithium chloride introduced, only a tenth of that used in the former being employed in the latter. It is plain that, when we are dealing with the larger amount, a larger portion tends to remain behind with the insoluble chloride; and here again we meet, though to a degree comparatively harmless, the inclination of lithium chloride to yield chlorine and pass to the form of lithium hydrate. When the lithium chloride is present in small amount, as in the latter group of experiments, there can be little left undissolved; and the spectroscope confirms the evidence of the figures of analysis as to the perfectness of the separation, by showing in such cases either no lithium at all or merely fugitive traces. If a single precipitation is sufficient to effect a satisfactory separation of the insoluble chlorides from small amounts of lithium chloride, it is natural to suppose that a repetition of the precipitation would be beneficial in treating larger quantities of lithium chloride. Experiments (32) to (37) illustrate the effect of a double precipitation. The chlorides were brought to filtration as before, the liquid was decanted as completely as possible, the precipitate washed slightly by decantation and re-dissolved in a little water, and the round of boiling, filtering, drying, and weighing carried to the end as before, care being taken to repeat the treatment with a drop of hydrochloric acid during the process of boiling. The two portions of residual amyl alcohol were measured apart, as well as the washings (See Table below).

Thus it appears that, in the separation of the insoluble chlorides from the larger amounts of lithium chloride, the residue of two precipitations is substantially free from lithium.

For the sake of bringing the data in hand more directly into comparison, the corrected errors of the preceding determinations are tabulated again in the following statement (See Table next page).

Few processes in analytical chemistry are capable of yielding results more exact than these. The separation of from 0·1 grm. to 0·2 grm. of sodium or potassium chloride from a tenth of its own weight of lithium chloride is practically perfect in one operation, and from its own weight of lithium chloride the parting may be effected satisfactorily by two precipitations.

The points to be observed in executing the method may be recapitulated as follows:—

To the concentrated solution of the chlorides, amyl alcohol is added and heat is applied, gently at first to avoid danger of bumping, until the water disappearing

* *Proceedings of the American Academy of Arts and Sciences*, 1886-1887.

	Weight of NaCl taken.	Weight of NaCl found.	Corrected weight of NaCl found.	Error in weight of NaCl found.	Error in corrected weight of NaCl found.	Volume of amyl alcohol used. Residual. I.	Residual. II.	Total.
	Grm.	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³	C.m.³
(32)	0·1166	0·1163	0·1169	0·0003 −	0·0003 +	8	8	150
(33)	0·1139	0·1127	0·1132	0·0012 −	0·0007 −	5	7	150

	Weight of LiCl taken.	Weight of Li_2SO_4 found.	Weight of LiCl found.	Corrected weight of LiCl found.	Error in weight of LiCl found.	Error in corrected weight of LiCl found.
	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
(32)	0·1287	0·1662	0·1284	0·1280	0·0003 −	0·0007 −
(33)	0·1347	0·1759	0·1359	0·1353	0·0012 +	0·0006 +

	Weight of KCl taken.	Weight of KCl found.	Corrected weight of KCl found.	Error in weight of KCl found.	Error in corrected weight of KCl found.	Volume of amyl alcohol used. Residual. I.	Residual. II.	Total.
	Grm.	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³	C.m.³
(34)	0·1155	0·1142	0·1152	0·0013 −	0·0003 −	10	10	100
(35)	0·1034	0·1017	0·1028	0·0017 −	0·0007 −	10	12	200
(36)	0·1914	0·1905	0·1912	0·0009 −	0·0002 −	3	11	90
(37)	0·1953	0·1939	0·1950	0·0014 −	0·0003 −	4	18	110

	Weight of LiCl taken.	Weight of Li_2SO_4 found.	Weight of LiCl found.	Corrected weight of Li Cl found.	Error in weight of LiCl found.	Error in corrected weight of LiCl found.
	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
(34)	0·1125	0·1475	0·1139	0·1128	0·0014 +	0·0003 +
(35)	0·1251	0·1649	0·1274	0·1162	0·0023 +	0·0011 +
(36)	0·1263		—	—	—	—
(37)	0·1282	—	—		—	

No. Exp.	Chloride.	Corrected Error of Insoluble Chloride: Precipitated *once* from about 0·13 grm. of LiCl.	Precipitated *once* from about 0·013 grm. of LiCl.	Precipitated *twice* from about 0·13 grm. of LiCl.	Error in corrected weight of LiCl.	Approximate mean error of LiCl.
		Grm.	Grm.	Grm.	Grm.	Grm.
(23)	NaCl	0·0006+	—	—	0·0002−	0·0005+
(24)	,,	0·0006+	—	—	0·0002−	
(26)	KCl	0·0002+	—	—	0·0008−	
(27)	,,	0·0010+	—	—	0·0010−	
(25)	NaCl	—	0·0000	—	—	
(28)	KCl	—	0·0005−	—	—	
(29)	,,	—	0·0004−	—	—	
(30)	NaCl+KCl	—	0·0000	—	—	
(31)	,, ,,	—	0·0007+	—	—	
(32)	NaCl	—	—	0·0003+	0·0007−	0·0003−
(33)	,,	—	—	0·0007−	0·0006+	
(34)	KCl	—	—	0·0003−	0·0003+	
(35)	,,	—	—	0·0007−	0·0011+	
(36)	,,	—	—	0·0002−	—	
(37)	,,	—	—	0·0003−	—	
	Approximate mean,	0·0006+	0·00004−	0·0003−		

from solution and the point of ebullition rising and becoming constant for some minutes at a temperature which is approximately that at which the alcohol boils by itself, the chlorides of sodium and potassium are deposited and lithium chloride is dehydrated and taken into solution. At this stage in the operation the liquid is cooled and a drop or two of strong hydrochloric acid added to re-convert traces of lithium hydrate in the deposit, and the boiling continued until the alcohol is again free from water. If the amount of lithium chloride present is small it will now be found in solution, and the chlorides of sodium and potassium will be in the residue, excepting the traces, for which correction will be made subsequently. If, however, the weight of lithium chloride present exceeds ten or twenty m.grms., it is advisable at this point, though not absolutely essential to the attainment of fairly correct results, to decant the liquid from the residue, wash the latter a little with anhydrous amyl alcohol, dissolve in a few drops of water, and repeat the separation by boiling again in amyl alcohol. For washing, amyl alcohol previously dehydrated by boiling is to be used, and the filtrates are to be measured apart from the washings. In filtering it is best to make use of the perforated crucible and asbestos felt, and apply gentle pressure. The crucible and residue are ready for the balance after drying for a few minutes directly over a flame turned low. The weight of insoluble chlorides actually obtained in this manner is to be corrected by the addition of 0·00041 grm. for every 10 c.m.^{3} of amyl alcohol in the filtrate exclusive of washings if the insoluble salt is entirely sodium chloride, 0·00051 grm. for every 10 c.m.^{3} if potassium chloride constitutes the residue, and if both sodium and potassium chloride are present, 0·00092 grm. ; but, as in the experiments described, the entire correction may in any case be kept within narrow limits, if due care be given to the reduction of the volume of residual alcohol before filtration. The filtrate and washings are evaporated to dryness, treated with sulphuric acid, the excess of the latter driven off, and the residue ignited to fusion and weighed. From the weight thus found the subtraction of 0·00050 grm. is to be made if sodium chloride constitutes the precipitate, 0·00059 grm. if potassium chloride alone is present in the residue, and 0·00109 if both of these chlorides are present, for every 10 c.m.^{3} of filtrate exclusive of washings.

Amyl alcohol is not costly, the manipulations of the process are easy, and the only objectionable feature—the development of the fumes of amyl alcohol—is one which is insignificant when good ventilation is available.

The process has been used for some months frequently and successfully, by others as well as myself, for the estimation of lithium in waters and minerals.

To be continued).

NOTICES OF BOOKS.

Report on the Waters of the Hudson River, together with an Analysis of the Same, made to the Water Commissioners of the City of Albany. By O. F. Chandler, Ph.D. January, 1885. New York: Trows.

This report gives, upon the whole, a favourable account of the Hudson River, as being, in purity, little inferior to the Croton. The total mineral matter is given as 8·313 grains per U.S. gallon of 231 cubic inches, the weight of this quantity being, unfortunately, not stated. He considers that rivers polluted with sewage are capable of self-purification by natural processes, except the impurities are introduced in immoderate quantities. He upholds chemical analysis as the means for determining the safety or danger of a water-supply. He does not indeed contend that chemistry can discriminate between pathogenic or septic microbia and such as are harmless, but he maintains that whenever mischief has been traced to a water, such water presented features which would ensure its condemnation on chemical principles. He has only a very qualified faith in the conclusiveness of biological and microscopical examination, on account of the practical omnipresence of the germs of bacteria. He writes that "when the biologist learns to detect in water the specific poisons of zymotic diseases and to distinguish them from the harmless organisms that we eat, drink, and breathe with impunity all our lives, then we may set up biological analysis as superior to chemical analysis." He supports these views by quotations from the late R. Angus Smith, Letheby, and Pettenkofer. Says the last-mentioned authority, "while Koch was in Calcutta the English physicians imbued him with their views on cholera and drinking-water. The English had been brought up on the drinking-water theory of typhoid fever and cholera, and could only lay it aside with difficulty."

In conclusion he maintains that the Hudson River furnishes a pure and safe water for the city of Albany, and that it would be foolish to incur heavy expenditure in introducing a new supply. The causes of zymotic disease, it is to be feared, are not quite so simple as it has been imagined, and we cannot hope to overcome them by the expedient of a pure water supply.

Index to the Literature of Explosives (Part I.). By Charles E. Munroe, S.B. (Harv.), Professor of Chemistry, U.S. Naval Academy. 1886. Baltimore: Isaac Friedenwald.

This index is intended to embrace not only such articles as treat of the composition and of the chemical and physical properties of explosive substances, but also of their manu-

facture and use in the arts. This part contains the titles of papers appearing in such periodicals as the indexer has been able to review from the date of first issue. 442 volumes have been thus reviewed for this part. Many other titles of papers have been collected, but the indexer has not yet had access to complete sets of the periodicals from which they have been gathered. A large number of titles of separate publications, treatises, text-books, and the like have also been collected. It is hoped that it will be possible to eventually publish these, together with a "subject" and "author's" index to the entire list.

CORRESPONDENCE.

ALKALI—CALIFORNIA.

To the Editor of the Chemical News.

Sir,—During my residence in California I had continual occasion to observe the effect of alkali in the soil. So pernicious is this substance that immense tracts of land lie uncultivated that would otherwise be covered with fruit trees or corn.

This efflorescence makes its appearance on the surface after rain or irrigation like snow, on loose soil and on hard ground like thin sheets of ice.

No remedy is yet known to neutralise its effect on vegetation, and, with the hope that this short letter may direct the attention of scientific men, I will add that I am willing to give any information in my power and supply a sample of alkali.

The first point would be to ascertain what it really is; as far as my experience goes I should call it a neutral salt, but scientific men alone can determine this, and suggest a means of neutralising its effect on vegetation.

It may prove to have a commercial value as manure.—I am, &c.,

W. R. Beauchamp.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ciii., No. 26, December 27, 1886.

This number contains the speech of the president, M. Jurien de la Gravière, delivered at the annual public session of the Academy on Dec. 27, and an account of the various prizes awarded or offered for special researches.

Biedermann's Central Blatt für Agrikultur Chemie. Vol. xv., Part 8.

Oxygen of Air in Forests.—Prof. Erbenmeyer.—Comparative determinations made in forest air and in air from the open country show a slight preponderance of oxygen in the latter, amounting in the mean to 0·04 volume per cent, but these differences appear chiefly due to small errors in the process of examination. Air collected in calm sunny weather, immediately over the leaves, was found occasionally richer in oxygen than air from the open country. But air taken in the interior of dense thickets, between the soil and the tree-tops, was frequently rather poorer in oxygen, which may be due to the consumption of oxygen during the eremacausis of vegetable matter. Certainly there can be no at all appreciable excess of oxygen in the forests. Still, country air and especially forest air, have essential advantages as compared with town air, due to the comparative scarcity of dust, microbia, and offensive products of decomposition and putrefaction. The sanitary value of forests must rank very high.

Nitrogen Gas in Sea-Water.—Axel Hamberg.—From the *Journal für Praktische Chemie.*

Carbonic Acid in Sea-Water.—Axel Hamberg.—From the *Journal für Praktische Chemie.*

Fixation of Nitrogen in Cultivated Soils.—H. Joulie.—The author's experiments were made in conical glass flower-pots placed in a conservatory roofed with glass, but inclosed on the sides only with wire-gauze. An increase of nitrogen in the soil was observed in every case save one, though the arrangements excluded all considerable errors, such as may occur in experiments in an open field. According to Berthelot the fixation of atmospheric nitrogen is effected by micro-organisms, with which view the author agrees to a certain extent. In addition the plants cultivated in the soil are not without influence, and the manuring plays, beyond doubt, a capital part. The addition of marl proved most favourable, whilst the absence of potash and phosphoric acid, and above all the application of organic manures, acted unfavourably.

Contributions to the Study of Farm-yard Manure.—A. Audcynaud and E. Zacharewicz.—The food of the animals contained yearly 344·7 kilos. nitrogen and 188·7 potash, whilst the liquid and solid excrements contained only 158·8 nitrogen and 52·8 potash, showing a loss of 185·9 kilos, nitrogen and 135·9 potash. The skin of the horse, like that that of the sheep, exudes very considerable quantities of potash.

Manurial Experiments with Phosphates.—Prof. J. Fittbogen.—Ground basic slag and the precipitates obtained from it under the patents of Scheibler and Hoyermann are capable of supplying barley with the phosphoric acid necessary for a normal crop. The total of phosphoric acid required for this purpose was, however, twice as great as would have sufficed if it had been supplied as a mono- or di-calcium compound. An addition of humus improves the efficacy, both of the ground slag and of the precipitates. The precipitates do not seem to have any advantage over the ground slag.

Utilisation of Cellulose in the Animal Organism.—Prof. Waldemar von Knieriem.—Crude fibre must not be regarded as mere useless ballast in the food of plant-eating animals. It gives a looser texture to the contents of the bowel, and obviates the danger of obstructions. The products formed during its solution economise both fatty matters and albumenoids in the organism.

Action of Climatic Factors upon the Growth of the Potato.—Dr. F. C. Tschaplowitz.—This memoir does not admit of useful abstraction.

Formation of Oxalic Acid in Plants.—MM. Berthelot and André.—From the *Comptes Rendus.*

Rancidity of Butter.—E. Duclaux.—From the *Comptes Rendus.*

Examinations of Milk in the Laboratory of the Aylesbury Dairy Company.—Dr. P. Vieth.—If the liquid portion is removed from a partially frozen sample of milk, the ice on thawing has the composition of a watered milk. The insoluble fatty acids in pure butter range from 87·17 to 88·85, whilst in oleomargarine they reach 95·37.

Preparation of Red Wines.—Dr. J. Nessler.—To obtain the fullest natural colour, the fermentation should be conducted at 14° to 20°. The skins of the grapes should not be excessively comminuted. If the wine is allowed to remain in contact with the skins, stalks, &c., after the fermentation is completed a part of the colour is withdrawn from the liquid.

Method for Determining Fusel Oil in Alcohol, especially in Brandy and Liqueurs.—J. Traube.—The author rejects the methods now in use, and describes a

new capillarimetric process, by which fusel can be determined to about 1-50 per cent. It depends upon the fact that the rise of the aqueous solutions of organic bodies of a homologous series at the same percentage, often decreases very considerably with an increasing molecular weight of the dissolved body. Hence, especially on proper dilution, a very small proportion of fusel in brandy, &c., may be recognised by the decrease in the capillary ascent. The compounds present in fusel, the propylic and butylic alcohols, and the various aldehyds, including furfurol, reduce the ascent more than ethylic alcohol but less than amylic alcohol. The author's apparatus consists essentially of a very thin capillary tube, as narrow as possible, secured to a very fine scale, graduated in half millimetres. It terminates at its zero in two points which may be fixed exactly at the level of the liquid by means of screws. The capillary tube may easily be kept clean if it is rinsed after every experiment with water and alcohol and a current of dry air, free from dust, is drawn through it. The liquid is sucked up in the capillary two or three times and the position of the lower meniscus is read off a few hours after the liquid has come to rest. This can be done to 1-10th of a m.m., even without a lens. Liqueurs, in which the specific gravity of the distillate differs considerably from that of the original liquid, are first distilled and then diluted with water to a specific gravity corresponding to a 20 per cent (by volume) dilution of alcohol. The capillary rise, compared with that of a pure 20 per cent alcohol, shows the proportion of fusel. Differences of temperature require a very small correction.

On Barley, Rain-drenched and Dry.—Prof. Farsky.—Both the albumenoids and the carbohydrates undergo an extensive decomposition in barley which has been exposed to rain.

Alleged Addition of Glycerin to the Bremen "Rose" and "Apostle" Wines.—E. Winckelmann has recently insinuated that certain old wines in the Bremen "Council Cellar," especially the 1653 Rudesheim kept in the "Rose" vat, and the 1726 Hockheim in the "Apostle" vat, have recently received an addition of glycerin. He founds this charge on two analyses, which show that the above wines contain respectively 1 and 1·02 per cent of glycerin. E. Borgmann and J. Moritz (*Chemiker Zeitung*), two specialists, have proved, on the contrary, that the percentage of glycerin in notoriously old wines may be very high.

Reduction of Calcium Sulphate by Certain Anærobic Ferments.—M. Quantin.—The author observed the liberation of hydrogen sulphide due to the reduction of calcium sulphate. The process took place in cellulose, to which the microbia from swamps and mud had been added. On destroying the organisms by an addition of chloroform the reduction came to an end.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., January, 1887.

Manufacture of Safranine.—Dr. Otto Mühlhaeuser.—A very complete account of the preparation of this colour, including a specification of the plant required for a daily yield of 36 kilos.

Process for Determining the Number of Methoxylic Groups (OCH_3) contained in an Organic Derivative.—Zeisel.—The process consists in heating the compound with hydriodic acid (prepared by means of phosphorus and of the spec. grav. 1·68) and in receiving the methyl iodide given off in an alcoholic solution of silver nitrate (two parts of the silver salt, five parts of water, and 45 c.c. of absolute alcohol). Silver iodide is formed, 1(AgI) corresponding to 1(OCH_3).

Researches on Papaverine.—C. Goldschmied.—This acid, when pure, forms rhombic crystals, fusible at 147—148°, scarcely soluble in boiling water, very soluble in boiling alcohol, benzene, and acetic acid. With hot sulphuric acid it gives a violet colouration. It contains four methoxylic groups. The product resulting from the action of hydriodic acid contains four hydroxyles, and is named papaveroline.

Patents Concerning Colouring Matters Taken at Berlin:—

Improvements in the preparation of naphtholcarbonic acids or oxynaphthoic acids.—Dr. Von Heyden.

Preparation of benzidine-monosulphonic acid and colouring matters derived from the tetrazo-compound of this acid.—Fr. Bayer.

Preparation of soluble indulines by the reaction of aromatic diamines upon the amidoazo-compounds, oxidation of colouring matters upon the fibre.—Dahl and Co.

Preparation of the derivatives of quinizine by the action of hydrazobenzol and its homologues upon acetylacetic ether and the substitution products of this ether.—Bâle Chemical Company.

Preparation of a green-colouring matter.—Gustav Vendt.

Preparation of the mono- and disulphonic acids of tetramethyl diamido-benzophenone and tetraethyl diamido-benzophenone.—Meister, Lucius, and Brüning.

Preparation of dialkyloxylated diquinolyles and of their hydrogenated derivatives.—Bayer and Co.

Preparation of thiobenzidine, thiotolidine, and their coloured derivatives.—Dahl and Co.

Brown colouring-matters obtained by the reaction of metaphenylen-diamine or meta-toluylene-diamine upon amido-azobenzol, amido-azotoluol, amido-azoxylol, and amido-azoanisol.—Bâle Chemical Company.

Transformation of paranitrotoluene-sulphonic acid into a condensed amido-acid and into derived azo-colours.—Leonhard and Co.

Process for preparing the indol derivatives by means of the combinations formed by aromatic hydrazines with the acetones and the aldehyds treated with agents capable of removing the elements of ammonia.—Meister, Lucius, and Brüning.

Preparation of green colouring-matters by means of methylene and ethylene blues.—Meister, Lucius, and Brüning.

Preparation of diamidic and tetra-alkylic thiobenzophenones—Baden Aniline Company.

Preparation of dinitrodibenzyl.—Dr. L. F. Roser.

Preparation of a new β-naphthylamine-sulphonic acid of derived azo-colours.—Bayer and Co.

Qualitative Analysis of Artificial Colouring Matters.—A most valuable paper, but unfit for abstraction, and, from its bulk, incapable of reproduction in full.

On β-Sulpho-conjugated Phthalic Acid.—A. Ree.—From the *Journal of the Chemical Society*.

Fortification of Wines.—The Academy of Medicine, after a discussion extending over several sessions, has resolved that—The fortification of wines by means of pure alcohol and not beyond two degrees may be tolerated, but except under these conditions it should be absolutely prohibited. Fortification is dangerous, not only from the quantity and often from the bad quality of the alcohol added to wine, but also because it permits of subsequent watering. The so-called higher alcohols increase considerably the dangers of brandies and liqueurs. There is, therefore, reason to demand that the alcohol used in preparing these products should be absolutely pure.

Use of an Aniline Black Varnish for the Preservation of Leather.—L. Benoist.—This varnish, the preparation of which is not given, is said to entirely prevent leather from turning mouldy on exposure to moist air.

The Causes of Paper Turning Yellow.—Prof. Wiesner.—The author contends that the yellowing of paper is due to an oxidation determined by light, and especially by the more refrangible rays. This discolouration is more striking in wood-papers than in rag-papers.

Dry air is another important condition for the preservation of paper. The author thinks that in libraries the electric light is inferior to gas, on account of the large proportion of the more refrangible rays present in the former.

Manufacture of Sodium Dichromate.—The author uses six parts of ground chrome ore (containing 44 per cent of chromic oxide), three parts soda-ash (at 92 per cent actual carbonate), and three parts of chalk, for eight hours in the oxidising flame of a furnace capable of holding one ton of mixture. The more chromic acid is present in the finished product the more it tends to deliquesce.

Journal für Praktische Chemie.
New Series, Vol. xxxiv., Part 10, 1886.

On the Oxy-acids of Iodine.—C. W. Blomstrand.—About few inorganic acids has so much been said as about the oxy-acids of iodine. The theory of types alone lays especial difficulties in the way of a satisfactory interpretation of these acids. As iodine itself reminds us of the metals, it may be said of periodic acid that it forms a transition to the metallic acids. This becomes evident if we compare the periodates with the salts of tungstic and molybdic acids.

Researches from the Laboratory of Prof. A. Saytzeff, of Kasan.—These comprise memoirs by S. Barataeff and A. Saytzeff, on the action of iodethyl and zinc upon diethylketone on the synthesis of triethel carbinol; by D. Ustinoff and A. Saytzeff, on the action of iodpropyl and zinc upon butyron; formation of dipropylcarbonol; by A. Albitzky and W. Nikolsky, on a non-volatile product of the oxidation of the hydrocarbon $C_{12}H_{20}$ obtained from allyl-dimethyl-carbinol; by D. Ustinoff, on the β-dimethyl-acrylic acid from β-dimethyl-ethylen-lactic acid obtained by the oxidation of allyl-dimethyl-carbinol; by E. Schatzky, on diallyloxalic acid and on the preparation of oxalic ether.

Transferrers of Halogens.—L. Meyer.—Referring to a paper on this subject by C. Willgerodt, the author states that whilst the facts laid down agree, for the most part, with those previously ascertained in the Tübingen laboratory, the inferences drawn seem in many cases premature, if not hazardous. Willgerodt is in error in assuming that the results of Page and Schenfelen are contradictory.

Part 11.

Behaviour of Iodine with Realgar and an Arsen-iodosulphide.—R. Schneider.—This compound, $AsI_3As_2S_3$, is a perfectly amorphous, vitreous mass, of a conchoidal fracture and a colour varying from ruby-red to reddish-brown. At ordinary temperatures it is permanent in the air. It softens at 100°, and if heated more strongly it becomes a thin liquid. It is capable of distillation, but is partially decomposed.

Weights of Drops and their Relation to the Constants of Capillarity and on the Capillary Marginal Angle.—J. Traube (conclusion).—The weight of drops, or the constant of capillarity, decreases with an increasing curvature of the formative surface of the drop. This decrease sets in at a certain degree of curvature, which differs for different liquids. The decrease of the weight of drops for different liquids is not proportional to the increase of curvature, but seems to be the greater the smaller the coefficient of capillarity of the liquid.

New Apparatus for Electro-chemical Researches.—M. von Klobulow.—This memoir requires the accompanying figures.

Transferrers of the Halogens.—C. Willgerodt.—The author replies to Lothar Meyer's paper in No. 10, and points out the difference between his own researches and those of Meyer and his pupils.

NOTES AND QUERIES.

**** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Partial Analyses of Two Samples of Sea-water, respectively taken at Scarborough and Blackpool on August 26, 1886.—By ROWLAND WILLIAMS, F.C.S.:—

	Grains per gallon. Scarborough.	Blackpool.
Total solids (dried at 220° F.)	2730·55	2499·63
Chlorine (Cl)	1346·45	1239·52
Sulphuric anhydride (SO_3)..	154·84	115·71
Lime (CaO)	36·42	46·28
Magnesia (MgO)	158·76	144·62
Specific gravity at 60° F.	1·0275	1·0244

MEETINGS FOR THE WEEK.

MONDAY, 7th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "The Diseases of Plants," by Dr. Thudichum.
—— Society of Chemical Industry, 8. "A New Method of Elevating Liquids, especially Acids," by Mr. J. Mactear; and other papers.
—— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 8th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8. (Anniversary).
WEDNESDAY, 9th.—Society of Arts, 8. "Purity of Beer," by A. Gordon Salamon.
—— Geological, 8.
—— Microscopical, 8. (Aniversary).
—— Pharmaceutical, 8.
THURSDAY, 10th.—Royal, 4 30.
—— London Institution, 6.
—— Royal Institution, 3. "Molecular Forces," by Prof. A. W. Rücker, F.R.S.
—— Mathematical, 8.
—— Telegraph Engineers, 8.
FRIDAY, 11th.—Royal Institution, 9. "Gilded Chrysalides," by E. B. Poulton, M.A.
—— Quekett Club, 8.
—— Astronomical, 3. (Anniveisary).
—— Society of Arts, 8. "The Economical Condition of India," by Dr. George Watt, C.I.E.
SATURDAY 12th.—Royal Institution, 3. "Modern Composers of Classical Song—Rubinstein, Raff, and Grieg," by Carl Armbruster.
—— Physical, 3. Annual General Meeting. "Note on the Tenacity of Spun Glass," by E. Gibson and R. A. Gregory.

TO CORRESPONDENTS.

Subscriber.—Write to the Secretary of the Institute of Chemistry, 9, Adelphi Terrace, W.C.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to WILLIAM LLOYD WISE for "Improvements in the manufacture or production of caustic alkalies, caustic baryta, and caustic strontia (a communication), dated the 14th September, 1882, No. 4364.

NOTICE IS HEREBY GIVEN that Solvay and Company, of Brussels, Belgium (Assignees of the said Letters Patent) have applied for leave to amend the specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and particulars of the proposed amendments are set forth in the Official Journal of the Patent Office issued on the 26th January, 1887.

Any person intending to oppose the said application must leave particulars of his objections thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date hereof.

Dated this 26th day of January, 1887.

(Signed) H. READER LACK,
Comptroller-General.

W. LLOYD WISE,
46, Lincoln's Inn Fields, W.C.,
Applicant's Agent.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S, Ardwick Chemical Works, Manchester.

THE CHEMICAL NEWS.

Vol. LV. No. 1420.

ON NICKEL PLATING.

By THOMAS T. P. BRUCE WARREN.

As I have not met with any reliable account of nickel plating, I am induced to put the following remarks together.

The compound used principally for the electro-deposition of nickel is a double sulphate of nickel and ammonia. The silvery appearance of the deposit depends mainly on the purity of the salt as well as the anodes. The condition of the bath, as to age, temperature, and degree of saturation, position of anodes, strength of current, and other details of manipulation, which require care, cleanliness, and experience, such as may be met with in any intelligent workman fairly acquainted with his business, are easily acquired.

In the present paper I shall deal principally with the chemical department of this subject, and shall briefly introduce, where necessary, allusion to the mechanical and electrical details connected with the process. At a future time I shall be glad to enlarge upon this part of the subject, with a view of making the article complete.

A short time ago nickel plating was nearly as expensive as silver plating. This is explained by the fact that only a few people, at least in this country, were expert in the mechanical portions of the process, and only a very few chemists gave attention to the matter; to this must be added that our text-books were fearfully deficient in information bearing on this subject.

The salt used, and also the anodes, were originally introduced into this country from America, and latterly from Germany. I am not aware of any English manufacturer who makes a speciality in the way of anodes; this is a matter on which we can hardly congratulate ourselves, as a well-known London firm some time ago supplied me with my first experimental anodes, which were in every way very superior to the German or American productions; although the price paid per pound was greater, the plates themselves were cheaper on account of their lesser thickness.

The texture of the inner portions of these foreign anodes would lead one to infer that the metallurgy of nickel was very primitive. A good homogeneous plate can be produced, still the spongy rotten plates of foreign manufacture were allowed the free run of our markets. The German plates are, in my opinion, more compact than the American. A serious fault with plates of earlier manufacture was their crumpled condition after a little use; this involved a difficulty in cleaning them when necessary. The English plates were not open to this objection; in fact, when the outer surfaces were planed away, they remained perfectly smooth and compact.

Large plates have been known to disintegrate and fall to pieces after being used for some time. A large anode surface, compared with that of the article to be plated, is of paramount importance; the tank should be sufficiently wide to take the largest article for plating, and to admit of the anodes being moved nearer to or further from the article; in this way the necessary electrical resistance can very conveniently be inserted between the anode and cathode surfaces. The elimination of hydrogen from the cathode must be avoided, or at any rate must not accumulate; moving the article being plated, whilst in the bath, taking care not to break the electrical contacts, is a good security against a streaky or foggy appearance in the deposit.

At one time a mechanical arrrangement was made, by which the cathodes were kept in motion. The addition of a little borax to the bath is a great advantage in mitigating the appearance of gas. Its behaviour is electrical rather than chemical. If the anode surface is too great, a few plates should be transferred to the cathode bars.

When an article has been nickel plated it generally presents a dull appearance, resembling frosted silver. To get over this I tried, some time ago, the use of bisulphide of carbon in the same way as used for obtaining a bright silver deposit; curiously the deposit was very dark, almost black, which could not be buffed or polished bright; but by using a very small quantity of the bisulphide mixture, the plated surfaces were so bright that the use of polishing mops or buffs could be almost dispensed with. When we consider the amount of labour required in polishing a nickel-plated article, and the impossibility of finishing off bright an undercut surface, this becomes an important addendum to the nickel-plater's list of odds and ends.

This mixture is made precisely in the same way as for bright silvering, but a great deal less is to be added to the bath, about one pint per 100 gallons; it should be well stirred in, after the day's work is done, when the bath will be in proper condition for working next day. The mixture is made by shaking together, in a glass bottle, one ounce bisulphide, and one gallon of the plating liquid; allow to stand untill excess of bisulphide has settled, and decant the clear liquid for use as required. It is better to add this by degrees than to run the risk of overdoing; if too much is added the bath is not of necessity spoiled, but it takes a great deal of working to bring it in order again.

About eight ounces of the double sulphate to each gallon of distilled or rain water, is a good proportion to use when making up a bath. There is a slight excess with this; it is a mistake to add the salt afterwards, when the bath is in good condition. The chloride and cyanide are said to give good results; I can only say that the use of either of these salts has not led to promising results in my hands.

In preparing the double sulphate, English grain nickel is decidedly the best form of metal to use. In practice old anodes are generally used.

The metal is dissolved in a mixture of nitric and dilute sulphuric acid, with the application of a gentle heat. When sufficient metal has been dissolved, and the unused nitric acid expelled, the salt may be precipitated by a strong solution sulphate of ammonia, or, if much free acid is present, carbonate of ammonia is better to use.

Tin, lead, and portion of the iron, if present, are removed by this method; the silica, carbon, and portions of copper are left behind with the undissolved fragments of metals.

The precipitated salt, after slight washing, is dissolved in water and strong solution ammonia added; a clean iron plate is immersed in the solution to remove any trace of copper. This plate must be cleaned occasionally so as to remove any reduced copper, which will impede its action. As soon as the liquid is free from copper it is left alkaline and well stirred so as to facilitate peroxidation and removal of iron, which forms a film on the bath; when this ceases the liquid is rendered neutral by addition of sulphuric acid, and filtered or decanted. The solution, when properly diluted, has sp. gr. about 1·06 at 60° F. It is best to work the bath with a weak current for a short time until the liquid yields a fine white deposit; too strong a current must be avoided.

If the copper has not been removed it will deposit on the anodes when the bath is at rest; it should then be removed by scouring.

Copper produces a reddish tinge, which is by no means unpleasant compared with the dazzling whiteness of the nickel deposit; if this is desired it is far better to use a separate bath, using anodes of suitable composition.

The want of adhesion between the deposited coating and the article need not be feared if cleanliness be attended to and the article, whilst in the bath, be not touched by the hands.

The bath should be neutral, or nearly so, slightly acid rather than alkaline. It is obvious that, as such a liquid has no detergent action on a soiled surface, scrupulous care must be taken in scouring and rinsing. Boiling alkaline solutions and a free use of powdered pumice and the scrubbing brush must on no account be neglected.

A few words on the construction of the tanks. A stout wood box, which need not be watertight, is lined with sheet lead, the joints being blown, *not soldered*. An inner casing of wood, which projects a few inches above the lead lining is necessary in order to avoid any chance of "short circuiting" or damage to the lead from the accidental falling of anodes or any article which might cut the lead. It is by no means a necessity that the lining should be such as to prevent the liquid getting to the lead.

On a future occasion I hope to supplement this paper with the analysis of the double sulphates used, and an account of the behaviour of electrolytically prepared crucibles and dishes as compared with those now in the market.

ON ELECTRO-DISSOLUTION, AND ITS USE AS REGARDS ANALYSIS.

By H. N. WARREN, Research Analyst.

On the same principle that electro-dissolution is used for the estimation of combined carbon in steel, &c., I have lately varied the experiment by introducing, instead of steel, iron containing a certain percentage of boron, and, having connected the respective boride with the positive pole of a powerful battery, and to the negative a plate of platinum, using as a solvent dilute sulphuric acid, I observed, after the lapse of about twelve hours, the iron had entirely passed into solution, and a considerable amount of brownish precipitate had collected at the bottom of the vessel, intercepted by flakes of graphite and carbon: the precipitate, having been collected on a filter-paper, washed, and dried, on examination proved to be amorphous boron, containing graphite and other impurities, which had become chemically introduced during the preparation of the boron compound. The boron was next introduced into a small clay crucible, and intensely heated in a current of hydrogen gas, for the purpose of rendering it more dense and destroying its pyrophoric properties; and was lastly introduced into a combustion-tubing, heated to bright redness, and a stream of dry carbonic anhydride passed over it, in order to separate the carbon; finally, pure boron being obtained.

In like manner silicon-eisen, containing 9 per cent of silicon, was treated, but not giving so satisfactory a result. A small quantity only of silicon separates in the uncombined form, the greater quantity separating in the form of silica, SiO_2, the amorphous silicon so obtained apparently being more prone to oxidation than the boron so obtained.

Ferrous sulphide was next similarly treated, and gave, after the lapse of a few hours, a copious blackish precipitation of sulphur, and possessing properties similar to the sulphur obtained by dissolving sulphides such as cupric sulphide in dilute nitric acid, in all other respects resembling common sulphur.

Phosphides of iron, zinc, &c., were next introduced, and gave, besides carbon and other impurities, a residue containing a large percentage of phosphorus, which differed from ordinary phosphorus with respect to its insolubility in carbon disulphide, and which resembled the reaction in the case with silicon-eisen rather than that of the boron compound, insomuch that a large quantity of phosphorus had passed into solution.

A rod of impure copper, containing arsenic, iron, zinc, and other impurities, was next substituted, using hydrochloric acid as a solvent in place of sulphuric acid. In the course of a day the copper had entirely dissolved and precipitated itself on the negative electrode, the impurities remaining in solution. The copper, after having been washed, dried, and weighed, gave identical results with regard to percentage with a careful gravimetric estimation. I have lately used this method, and obtained excellent results with respect to the analysis of commercial copper, especially in the estimation of small quantities of arsenic, thus enabling the experimenter to perform his investigation on a much larger quantity than when precipitation is resorted to, at the same time avoiding the precipitated copper carrying down with it the arsenic. I have in this manner detected arsenic in commercial copper when all other methods have totally failed. I have also found the above method especially applicable with respect to the analysis of brass.

With respect to ammoniacal dissolution, of which I will briefly mention, a rod composed of an alloy of copper and silver was experimented upon, the copper becoming entirely dissolved and precipitating itself on the platinum electrode, the whole of the silver remaining suspended to the positive electrode in an arborescent form. Arsenide of zinc was similarly treated, the arsenic becoming precipitated in like manner on the platinum electrode. Various other alloys being experimented upon gave similar results.

I may also, in the last instance, mention that I have found the above methods of electro-dissolution peculiarly adapted for the preparation of unstable compounds such as stannic nitrate, potassic ferrate, ferric acetate, which are decomposed on the application of heat, and in some instances have succeeded by the following means of crystallising the resulting compound obtained.

ANALYSES OF COMMERCIAL FERTILISERS.*

Official Methods of the Association of Agricultural Chemists for 1886-7.

(Concluded from p. 53.)

Determintion of Nitrogen by the Method of Kjeldahl.

Reagents and Apparatus.

(1) Hydrochloric acid whose absolute strength has been determined (*a*) by precipitating with silver nitrate and weighing the silver chloride; (*b*) by sodium carbonate, as described in Fresenius's "Quantitative Analysis," 2nd American edition, p. 680; and (*c*) by determining the amount neutralised by the distillate from a weighed quantity of pure ammonium chloride boiled with an excess of sodium hydrate.

(2) Standard ammonia whose strength, relative to the acid, has been accurately determined.

(3) "C. P." sulphuric acid, sp. gr. 1·83, free from nitrates and also from ammonium sulphate, which is sometimes added in the process of manufacture to destroy oxides of nitrogen.

(4) Mercuric oxide, HgO, prepared in the wet way. That prepared from mercury nitrate cannot safely be used.

(5) Potassium permanganate, tolerably finely pulverised.

(6) Granulated zinc.

(7) A solution of 40 grms. of commercial potassium sulphide in 1 litre of water.

(8) A saturated solution of sodium hydrate free from nitrates, which are sometimes added in the process of manufacture to destroy organic matter and improve the colour of the product.

(9) Solution of cochineal prepared according to Fresenius's "Quantitative Analysis, 2nd American edition, p. 679.

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C., August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

(10) Burettes should be calibrated in all cases by the user.

(11) Digestion flasks of hard, moderately thick, well-annealed glass. These flasks are about 9 inches long, with a round, pear-shaped bottom, having a maximum diameter of 2½ inches, and tapering out gradually in a long neck, which is three-fourths of an inch in diameter at the narrowest part, and flared a little at the edge. The total capacity is 225 to 250 c.c.

(12) Distillation flasks of ordinary shape, 550 c.c. capacity, and fitted with a rubber stopper and a bulb tube above, to prevent the possibility of sodium hydrate being carried over mechanically during distillation. This is adjusted to the tube of the condenser by a rubber tube.

(13) A condenser. Several forms have been described, no one of which is equally convenient for all laboratories. The essential thing is that the tube which carries the steam to be condensed shall be of block tin. All kinds of glass are decomposed by steam and ammonia vapour, and will give up alkali enough to impair accuracy. (See Kreussler and Henzold, *Ber. Berichte*, xvii., 34.) The condenser in use at the laboratory of the Conn. Exp. Station, devised by Prof. Johnson, consists of a copper tank supported by a wooden frame, so that its bottom is 11 inches above the work-bench on which it stands. This tank is 16 inches high, 32 inches long, and 3 inches wide from front to back, widening above to 6 inches. It is provided with a water-supply tube which goes to the bottom, and a larger overflow pipe above. The block tin condensing tubes, whose external diameter is ⅞ths of an inch, seven in number, enter the tank through holes in the front side of it near the top, above the level of the overflow, and pass down perpendicularly through the tank and out through rubber stoppers tightly fitted into holes in the bottom. They project about 1½ inches below the bottom of the tank, and are connected by short rubber tubes with glass bulb tubes of the usual shape, which dip into glass precipitating beakers. These beakers are 6½ inches high, 3 inches in diameter below, somewhat narrower above, and of about 500 c.c. capacity. The titration can be made directly in them. The seven distillation flasks are supported on a sheet-iron shelf attached to the wooden frame that supports the tank in front of the latter. Where each flask is to stand a circular hole is cut, with three projecting lips, which support the wire gauze under the flask, and three other lips which hold the flask in place and prevent its moving laterally out of place while distillation is going on. Below this sheet-iron shelf is a metal tube carrying seven Bunsen burners, each with a stopcock like those of a gas combustion furnace. These burners are of larger diameter at the top, which prevents smoking when covered with fine gauze to prevent the flame from striking back.

(14) The stand for holding the digestion flasks consists of a pan of sheet-iron 29 inches long by 8 inches wide, on the front of which is fastened a shelf of sheet-iron as long as the pan, 5 inches wide, and 4 inches high. In this are cut six holes 1⅝ inches in diameter. At the back of the pan is a stout wire running lengthwise of the stand, 8 inches high, with a bend or depression opposite each hole in the shelf. The digestion flask rests with its lower part over a hole in the shelf, and its neck in one of the depressions in the wire frame, which holds it securely in position. Heat is supplied by low Bunsen burners below the shelf. Dr. Jenkins has used asbestos-paper under the flasks, but finds that with a little care the naked flame can be applied directly to the flask without danger.

The Determination.

One grm. of the substance to be analysed is brought into a digestion flask with approximately 0·7 grm. of mercuric oxide and 20 c.c. of sulphuric acid. The flask is placed on the frame above described in an inclined position, and heated below the boiling-point of the acid for from five to fifteen minutes, or until frothing has ceased. The heat is then raised till the acid boils briskly. No further attention is required till the contents of the flask has become a clear liquid, which is colourless, or at least has only a very pale straw colour. The flask is then removed from the frame, held upright, and, while still hot, potassium permanganate is dropped in carefullly and in small quantity at a time, till after shaking the liquid remains of a green or purple colour. After cooling, the contents of the flask are transferred to the distilling flask with water, and to this 25 c.c. of potassium sulphide are added, 50 c.c. of the soda solution, or sufficient to make the reaction strongly alkaline, and a few pieces of granulated zinc. The flask is at once connected with the condenser, and the contents of the flask are distilled till all ammonia has passed over into the standard acid contained in the precipitating flask previously described, and the concentrated solution can no longer be safely boiled. This operation usually requires from twenty to forty minutes. The distillate is then titrated with standard ammonia.

The use of mercuric oxide in this operation greatly shortens the time necessary for digestion, which is rarely over an hour and a half in the case of substances most difficult to oxidise, and is more commonly less than an hour. In most cases the use of potassium permanganate is quite unnecessary, but it is believed that in exceptional cases it is required for complete oxidation, and in view of the uncertainty it is always used. Potassium sulphide removes all mercury from solution, and so prevents the formation of mercuro-ammonium compounds which are not completely decomposed by soda solution. The addition of zinc gives rise to an evolution of hydrogen, and prevents violent bumping. Previous to use the reagents should be tested by a blank experiment with sugar, which will partially reduce any nitrates that are present which might otherwise escape notice.

This method cannot be used for the determination of nitrogen in substances which contain nitrates or certain albumenoids.

The following references to papers in which this method is discussed may be of service:—

Kjeldahl's original paper, Fres. Zeitschr., 1883, xxii., p. 366.

Descriptions of apparatus, modifications of the process, precautions to be observed, control determinations, &c.—Maercker, Fres. Zeitschr., 1884, 223, 559. Chem. Zeitg., viii., 432. Stutzer und Reitmar, Chem. Zeitg., 1885, No. 76, from Rep. Anal. Chem., 1885, v., 232. Pfeiffer und Lehmann, Fres. Zeitschr., 1885, xxiv., 388. Kreussler, Fres. Zeitschr., 1885, xxiv., 393, 453. Landw. Versuchs. Stationen, xxxi., 269. Dafert, Fres. Zeitschr., 1885, xxiv., 454. Wilfarth, Fres. Zeitschr., 1885, xxiv., 455. Chem. Centralblatt (3 F.), xvi., 17 and 113. Rindell und Hannin, Fres. Zeitschr., 1886, xxv., 155. Czeczetka, Fres. Zeitschr., 1886, xxv., 252.

Application to determination of nitrogen in *coke and coal*.—Sigismund und Schmitz, Fres. Zeitschr., 1886, xxv., 314. In *urine*.—Petri und Lehmann, Zeitschr. für Physiolog. Chem., viii., 200. Fres. Zeitschr., 1884, xxiii., 596. Pfluger und Bohland, Pfluger's Archiv, xxxv., 454. Fres. Zeitschr., 1885, xxiv., 299. Arnold, Répertoire d. Anal. Chem., iv., 97. Hofmeister. Fres. Zeitschr., xxiv., 635. Bohland, Pfluger's Archiv, xxxvii., 423. Fres. Zeitschr., 1886, xxv., 280. In *wine*, *must*, and *yeast*.—Fres. Zeitschr., 1886, xxv., 149. In *asparagin*, *aspartic acid*, *glutamin*, *glutamic acid*, *leucin*, *tyrosin*, *allantoin*, &c.—Bosshard, Fres. Zeitschr., 1885, xxiv., 199.

Application to physiological experiments in general.—Arnold, Archiv. d. Phar. (3 R.), xxiii., 177. Fres. Zeitschr. 1886, xxv., 454.

Determination of Nitrogen by the Ruffle Method.

Preparation of Reagents.

(1) A standard solution of sulphuric acid, half-normal, or 19·968 grms. SO_3 per litre.

(2) A standard solution of potassium hydrate, half-normal, or 27·991 grms. KOH per litre.

(3) An alcoholic solution of coralline.

(4) Hyposulphite mixture. Prepared by mixing equal parts by weight of dry slaked lime and finely-powdered crystallised sodium hyposulphite. This may be made in quantity, as it will keep dry for any length of time if kept in a well-stoppered bottle.

(5) Charcoal and sulphur mixture. This is prepared by mixing equal parts by weight of finely-powdered wood charcoal (N free) and flowers of sulphur. This must be kept in a glass-stoppered bottle. The purity of the reagents must be tested by a blank combustion.

(6) Ordinary granulated soda-lime.

Apparatus.

(1) Combustion tubes of hard Bohemian glass, 20 inches long and ½ inch internal diameter, drawn to a point.

(2) Three bulb 6-inch U-tubes, with glass stopcock.

(3) Aspirator.

Preparation.

(1) Clean and fill the U-tube with 10 c.c. of standard acid.

(2) Fit cork and glass connecting-tube. Fill the tube as follows: (1) A loosely-fitting plug of asbestos, previously ignited, and then 1 to 1½ inches of the hyposulphite mixture. (2) The weighed portion of the substance to be analysed is intimately mixed with an equal weight of the charcoal and sulphur mixture. (3) Pour on a piece of glazed paper, or porcelain mortar, a sufficient quantity of the hyposulphite mixture to fill about 10 inches of the tube; then add the substance to be analysed, as previously prepared: mix carefully and pour into the tube; shake down the contents of the tube; rinse off the paper or mortar with a small quantity of the hyposulphite mixture, and pour into the tube; then fill up with soda-lime to within 2 inches of the end of the tube. (4) Place another plug of ignited asbestos at the end of the tube, and close with a cork. (5) Hold the tube in a horizontal position, and tap on the table until there is a gas channel all along the top of the tube. Place in the furnace and make connection with the U-tube containing the acid. Aspirate and see that the apparatus is tight.

The Combustion.—Place the prepared combustion-tube in the furnace, letting the open end project a little so as not to burn the cork. Commence by heating the soda-lime portion until it is brought to a full red heat. Then turn up slowly jet after jet toward the other end of the tube, so that the bubbles come off two or three a second. When the whole tube is red-hot and the evolution of the gas has ceased, and the liquid in the U-tube begins to recede towards the furnace, attach the aspirator to the other limb of the U-tube, break off the end of the tube, and draw a current of air through for a few minutes. Detach the U-tube, and wash the contents into a beaker or porcelain basin; add a few drops of the coralline solution, and titrate.*

DETERMINATION OF NITROGEN BY THE SODA-LIME METHOD.

Select a tube of hard glass 14 to 16 inches long, draw one end of it to a fine point, and to the other end fit a cork, through which is passed a tube bent at right angles, the other end of which passes through a cork closing tightly one arm of a 6-inch three-bulbed U-tube with glass stopcock. Into the combustion-tube first slip a loosely-fitting plug of asbestos, previously ignited, and then 1½ to 2 inches of soda-lime. Weigh out from 0·7 to 2·8 grms. of the substance to be analysed, and mix it on a piece of glazed paper or porcelain mortar with some finely-pulverised soda-lime, and introduce the mixture into the combustion-tube. The paper or mortar is then rinsed out with a small quantity of soda-lime and poured into the tube. The tube is then filled up to within 1 to 2 inches of the open end with granulated soda-lime, then fill up with a plug of ignited asbestos. A free passage is formed for the evolved gases by holding the tube in a horizontal position and tapping gently on the table. Introduce the prepared combustion-tube into the furnace, letting the open end project a little so as not to burn the cork, supporting the U-tube by a clamp. The tube is then gradually heated, commencing at the fore part, nearest the cork, and progressing slowly towards the tail. The combustion should be conducted so as to obtain a steady and uninterrupted flow of gas. When properly carried out the acid in the U-tube is never coloured. When the acid begins to recede attach the aspirator to the other limb of the U-tube, and start it slowly, then break off the point of the combustion-tube and draw a current of air through the apparatus for a few minutes, in order to sweep all the ammonia into the acid.

Detach the U-tube and wash the contents into a beaker or porcelain basin, add a few drops of an alcoholic solution of coralline and titrate.

The standard acid, alkali, and indicator to be the same as that used in the Ruffle method.

* Cochineal may be found a better indicator, as the H_2S evolved in the combustion affects coralline.—(C. R.)

PROPOSED AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

On Wednesday, November 10th, 1886, a preliminary meeting of the delegates appointed by the principal Australasian societies was held, Mr. H. C. Russell, F.R.S., being in the chair. The object of the meeting was to consider the proposal for forming an Australasian Association for the Advancement of Science. The proposal has met with considerable support from nearly all the Australian societies, Prof. Liversidge, F.R.S., of the Royal Society of New South Wales, being a very energetic promoter of the scheme.

At the meeting referred to above it was decided to found the Society on the same lines as the British Association for the Advancement of Science, and a resolution was passed adopting the Rules as printed of the last-named Association. The objects of this new Association are in every way similar to those of the older one in England, even to the excursions to places of interest in the neighbourhood of the towns where the meetings are to be held.

The first and inaugural meeting is proposed to be held at Sydney, in the year 1888, that year being the hundredth anniversary of the founding of the colony of New South Wales.

The Committee meetings for making the preliminary arrangements are held at the House of the Royal Society of New South Wales, Elizabeth Street, Sydney. This Society is certainly doing its best for the advancement of Science in the Colonies, and with that object they have offered medals and money prizes for original researches on the following subjects:—

SERIES VI.—To be sent in not later than 1st May, 1887.

No. 20. On the Silver Ore Deposits of New South Wales. The Society's medal and £25.

21. Origin and Mode of Occurrence of Gold-bearing Veins and of the associated Minerals. The Society's medal and £25.

22. Influence of the Australian Climate in producing Modifications of Diseases. The Society's medal and £25.

23. On the Infusoria peculiar to Australia. The Society's medal and £25.

SERIES VII.—To be sent in not later than 1st May, 1888.

No. 24. Anatomy and Life History of the Echidna and Platypus. The Society's medal and £25.

25. Anatomy and Life History of Mollusca peculiar to Australia. The Society's medal and £25.

26. The Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales. The Society's medal and £25.

SERIES VIII.—To be sent in not later than 1st May, 1889.

No. 27. On the Chemistry of the Australian Gums and Resins. The Society's medal and £25.

28. On the Aborigines of Australia. The Society's medal and £25.

29. On the Iron Ore Deposits of New South Wales. The Society's medal and £25.

30. List of the Marine Fauna of Port Jackson, with Descriptive Notes as to Habits, Distribution, &c. The Society's medal and £25.

The competition is in no way confined to Members of the Society, nor to residents in Australia, but is open to all without any restriction whatever, excepting that a prize will not be awarded to a Member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way; the communication to be successful must be either wholly or in part the result of original observation or research on the part of the contributor.

The Society is fully sensible that the money value of the prize will not repay an investigator for the expenditure of his time and labour, but it is hoped that the honour will be regarded as a sufficient inducement and reward.

The successful papers will be published in the Society's annual volume. Fifty reprint copies will be furnished to the author free of expense.

Competitors are requested to write upon foolscap paper, on one side only. A motto must be used instead of the writer's name, and each paper must be accompanied by a sealed envelope bearing the motto outside and containing the writer's name and address inside.

All communications to be addressed to the Honorary Secretaries, who are Messrs. A. Liversidge and F. B. Kyngdon.

Such efforts as these are sure to command success, and we are happy to see that the scientific future of one of our finest Colonies is assured.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, February 3rd, 1887.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

CERTIFICATES were read for the first time in favour of Messrs. Cecil Howard Cribb, 38, Soho Square; Joseph Frank Geisler, Mercantile Exchange Buildings, Hudson and Harrison Streets, New York; Thomas Albert Hedley, 41, St. Jean Baptiste Street, Montreal; Joseph William O'Connor, Aberaeron Place, N.W.; Gerald Tattersal Moody, 229, Rye Hill, S.E.

The following were elected Fellows of the Society:—Messrs. William Henry Coates, Thomas Cooksey, Arthur Henry Downes, M.D., Hamilton Emmons, George Arthur Goyder, E. Hori, Hubert McKeow, J. F. McArthur, David Henry Nagel, Thomas Burden Reay, Charles E. Sohn, jun., Lionel W. Stansell, James Pim Strangman, D. A. Sutherland, Jokichi Takaminé.

The following papers were read:—

5. "*The Absorption of Gases by Carbon.*" By CHARLES J. BAKER.

A series of experiments are described in which carbon in the form of animal charcoal, previously heated *in vacuo*, was saturated with oxygen, both dry and moist, at a low temperature; the carbon thus treated, enclosed in a vacuous tube, was then heated for some time at 100°, and finally the absorbed gas was extracted and analysed.

Using moist oxygen, it was found that no gas was given off at 12° from the carbon which had been exposed for one hour at −15° in such an atmosphere; on heating the carbon thus treated at 100° during seven days, and then exhausting at this temperature, it gave about seven times its volume of gas, consisting of carbon dioxide. No carbon dioxide was produced on digesting carbon and water vapour for a similar period and then exhausting.

Using dry oxygen and proceeding similarly, no gas was given off from the charcoal at 100°; however, on raising the temperature to about 450°, gas was expelled, consisting mainly of carbon monoxide mixed with carbon dioxide. Dried carbon was then charged with dried carbon dioxide, and the gas was extracted by heating at about 450° as before; it consisted of carbon monoxide and dioxide, the proportion of the former being less the more carefully the carbon was dried. The author therefore concludes that the more carefully moisture is excluded the less does the carbon burn in the carbon dioxide which it absorbs; and, further, that carbon is burned directly to carbon monoxide by absorbed oxygen.

DISCUSSION.

Mr. F. J. M. PAGE asked whether the author had ascertained if the same carbon could be used repeatedly; that is to say, was it possible to burn away the whole of the carbon, or was the action confined to the surface?

Prof. ODLING, who had communicated the paper, said this had not been ascertained; he thought, however, it was probable that the carbon would become less and less absorptive, but that the action would continue in proportion as absorption took place.

6. "*An Explanation of the Laws which govern Substitution in the case of Benzenoid Compounds.*" By HENRY E. ARMSTRONG.

Certain mono-derivatives of benzene, especially those containing a hydrocarbon radicle, one of the halogens, hydroxyl or amidogen, yield a mixture of the para- and ortho-di-derivatives in proportions which vary both according to the nature of the compound dealt with and of the reagent, and the conditions under which the change is effected; and if produced at all, the meta-derivative is formed in but a small proportion. If, however, the radicle present in the mono-derivative be NO_2, COH, CO_2H, SO_3H, the meta-di-derivative appears invariably to be the chief product. Hitherto no explanation of this difference in the behaviour of the two series of mono-derivatives has even been suggested.

In seeking to arrive at an explanation it is necessary to form a clear conception of the manner in which "substitution" is effected. The author is of opinion that in the first instance an additive compound is formed, and he points out that Kekulé has long since insisted in the plainest terms on this interpretation of changes of so-called double decomposition.

He is inclined to believe that the tendency of negative to attract and combine with negative elements—to which he has of late frequently directed attention—is the effective cause, and that the additive compound is formed from those mono-derivatives which obey the "para-ortho law" by the fixation of the reacting molecule upon the carbon atom which carries the radicle: separation of water or halogen hydride ensuing thereon, the radicle of the reacting molecule assumes the place either of an ortho- or of a para-hydrogen atom. It is easy to understand the formation of the ortho-di-derivative, as the hydrogen-atom displaced is associated with a carbon-atom contiguous to that to which the reacting molecule attaches itself. The formation of the para-compound is attributed by the author to the tendency towards symmetry, so frequently evidenced in cases of isomeric change and in other ways by benzenoid compounds, and not to the existence of any direct connexion between carbon-atoms relatively in the para-position. The formation of meta-derivatives is be-

lieved by the author to result from the addition of the reacting molecule, not to the carbon-atom of the benzene ring, but *to the radicle* which in the mono-derivative is attached to one of the carbon-atoms of the ring; he is, however, of opinion that in order to explain why the additive compound thus constituted yields a meta-di-derivative, it will be necessary to obtain further information regarding the "dynamics" of such changes.

Discussion.

Professor Odling observed that any attempt to solve the problem of the action of the commonly employed reagents, chlorine or bromine, nitric acid and sulphuric acid on one set of phenic mono-derivatives to produce under ordinary conditions mainly para-di-derivatives, and on another set of phenic mono-derivatives to produce mainly meta-di-derivatives, was entitled to a thoughtful and grateful consideration. But in his opinion a distinction should be drawn between the abstract cause of the result—as when Prof. Armstrong attributed the habitual preferential formation of para-derivatives to the existence of a tendency to the formation of symmetric compounds, and the mechanism leading to the result—as when he represented the formation of ortho-derivatives as being an almost necessary consequence of the particular process by which he conceived the substitution to be effected. The former suggestion did not appear to help the matter forward very much; but the latter suggestion was at any rate in the nature of a real explanation; though, for himself, he was not prepared to admit the general principle; that the previous combination of reagents was an invariable and determining condition of their reaction. Under exposure to bright daylight, a mixture of equal volumes of chlorine and marsh-gas, for instance, reacted even with violence; and, in his opinion, while the evidence as to the fact of their previous combination was of the smallest, the evidence as to the previous combination being the determining condition of the reaction was none at all. Admitting, however, that in the case of phenic reactions a previous combination took place in the particular manner so ingeniously conceived by Professor Armstrong as favouring the production of ortho-compounds, the general question, exemplified in the special case of the nitro-bromo-derivatives, for instance, why, starting from the mono-bromo-derivative we should get mainly a para-di-derivative instead of an ortho-di-derivative, and why, starting from the mono-nitro-derivative we should get mainly a meta-di-derivative rather than either a para- or an ortho-di-derivative, still remained a problem, and one of very great interest, towards the solution of which Professor Armstrong had, at any rate, made a serious advance. It was clear that the nature of the product depended a good deal on the conditions of, and modes of effecting, the reaction; but having regard to the usual modes of experimenting, he was accustomed to point out that where the pre-existing radicle was one of the typical radicles formulated as Cl, OH, NH_2, and CH_3, respectively, or some closely related radicle, the tendency was to the formation of 1—4 di-derivatives; and that where the pre-existing radicle was one of the acidic radicles formulated as NO_2, SO_3H, and CO_2H, or some allied radicle, the tendency was to the production of 1—3 di-derivatives. Having regard to the want of absolute concordance even in the writings of the present day, and to the extreme confusion in the writings of the last twenty years, as to the attribution of the prefixes para-, ortho-, and meta-, he preferred to speak of the different sets of compounds as 1—4, and 1—2, and 1—3 derivatives respectively. At the same time the expression of the primary 1, in each case, was for the most part superfluous, and might be omitted with advantage; only, to avoid confusing the other numerals with multiples, it was preferable to denote them by means of the small Roman or italic figures used by doctors when writing their prescriptions, instead of by the usual Arabic figures. Thus while speaking of the two liquid dibromobenzenes, or as he preferred to call them dibromo-phenoenes, as one-two and one-three dibromophenoene respectively, he was accustomed to write and formulate them as ij-dibromo-phenoene or ij-$C_6H_4Br_2$, and iij-dibromo-phenoene or iij-$C_6H_4Br_2$ respectively, the so-printed names and formulæ being much shorter and clearer than those usually employed. These expressions, moreover, stand in direct relation to the facts that ij-dibromo-phenoene gives origin to two tribromo-derivatives, and that iij-dibromo-phenoene gives origin to three tribromo-derivatives. As regards the expression of the 1—4 or crystalline dibromo-phenoene, he was accustomed to write and formulate it as jv-dibromo-phenoene, or jv-$C_6H_4Br_2$; but it might be very well expressed as j-dibromo-phenoene or j-$C_6H_4Br_2$, which would associate it with the fact of its giving origin to one tribromo-phenoene only.

Mr. Groves referred to the absorption of chlorine in large quantity by chloroform and carbon tetrachloride, and thought that facts such as these ought to be taken into account. He did not think that the tendency to form symmetrical di-derivatives was so universal as suggested by the author: the formation of resorcinol from benzene-*para*disulphonic acid was a case in point.

Dr. W. H. Perkin, Jun., thought that the production from hydrazo-benzene, not only of benzidine but also of an isomer, was evidence against Dr. Armstrong's view as to the manner in which para-compounds were formed.

Dr. Armstrong, replying to Prof. Odling's objection that the para-derivative was the chief product, and not the ortho- as should be the case according to his (Dr. Armstrong's) explanation of the manner in which substitution was effected, said that this was by no means always the case: in a recent investigation of the chlorotoluenes, for example, it had been shown that about twice as much ortho- as para-dichlorotoluene was formed. The proportions in which para- and ortho-derivatives were formed appeared, however, to vary greatly, and to depend very much on the conditions obtaining at the time of change. He was of opinion that the behaviour of the paraffins afforded the strongest evidence in support of his view that addition preceded substitution: the affinity of the carbon-atoms being all but satisfied, especially in the lowest terms, substitution was effected but slowly in consequence of the small extent to which the chlorine was able to combine with the paraffin; and it was most important to observe that when chlorine had once become introduced, the introduction of other atoms could be effected more and more readily—the chlorine already introduced rendering the molecule more ready to combine with chlorine. Mr. Groves's reference to the solubility of chlorine in chloroform and carbon tetrachloride was most apposite. The behaviour of hydrazobenzene appeared to him to be perfectly in harmony with his views, the isomer formed along with benzidine being the ortho-compound. Cases such as were referred to by Mr. Groves were probably not simple isomeric changes, but involved the successive occurrence of several distinct changes.

7. "*Some Derivatives of Tetramethylene.*" By G. H Calman and Dr. W. H. Perkin, Jun.

On heating calcium tetramethylenemonocarboxylate with lime, a gas and an oil are produced, two-thirds of the former consisting of ethylene, and the remaining third being a mixture of hydrogen, methane, and carbonic oxide.

The oil contains two new ketones, namely, ditetramethylene ketone—

$$CH_2\begin{Bmatrix}CH_2\\CH_2\end{Bmatrix}CH\cdot CO\cdot CH\begin{Bmatrix}CH_2\\CH_2\end{Bmatrix}CH_2.$$ B.-p. 204—205°;

and methyltetramethylene ketone or acetyl-tetramethylene—

$$CH_3\cdot CO\cdot CH\begin{Bmatrix}CH_2\\CH_2\end{Bmatrix}CH_2.$$ B.-p. 137—138°.

Tetramethylene aldehyde has also been prepared by heating calcium tetramethylenemonocarboxylate with calcium formate; it boils at 115—117°.

8. "*Derivatives of Pentamethylene.*" By Dr. W. H. Perkin, Jun.

The sodium-derivative of ethyl malonate is converted by the action of trimethylene bromide into ethylic tetramethylenedicarboxylate and ethylpentane-ω_2 ω_2-tetracarboxylate,—

$$(COOEt)_2{\cdot}CH{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH(COOEt)_2.$$

On hydrolysis this latter yields the tetracarboxylic acid, which on heating to 200° is converted into α-pimelic acid and carbonic anhydride.

If ethylic pentanetetracarboxylate be treated with sodic ethylate, a disodium compound,—

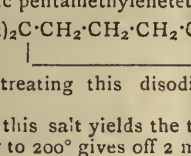
$$(COOEt)CNa{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CNa{\cdot}(COOEt)_2,$$

is formed: ethylic pentamethylenetetracarboxylate,—

$$(COOEt)_2C{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}C(COOEt)_2,$$

is obtained by treating this disodium-derivative with bromine.

On hydrolysis this salt yields the tetracarboxylic acid, which on heating to 200° gives off 2 molecules of carbonic anhydride, being converted into pentamethylenedicarboxylic acid,—



a crystalline body melting at 160°.

Ethylic pentamethylenedicarboxylate is a disagreeably smelling oil, boiling at 249—252°.

Pentamethylenedicarboxlic anhydride melts at 64—67°.

Discussion.

Dr. A. K. Miller asked, Had Dr. Perkin made any attempts to prepare hexamethylene rings? Reactions which would furnish compounds so constituted might easily be suggested; and their production would afford considerable support to the arguments adduced in favour of the view that those now described were tetra- and pentamethylene ring-compounds.

Dr. Armstrong remarked on the peculiarly interesting and valuable character of Dr. Perkin's work. In his paper on tetramethylene compounds Dr. Perkin had most clearly established the difference between what he called tetramethylene compounds and the *known* isomeric allyl-derivatives which it was conceivable might be formed in reactions such as were described; but it did not follow from this that the bodies in question were tetramethylene compounds: we were admittedly dealing with bodies of a novel type, and it was therefore necessary to be very cautious in applying knowledge gained by study of their physical properties, as we were unacquainted with the properties of any comparable series of compounds. Great differences were to be noted between maleic and fumaric acids, and between citra-, ita-, and mesaconic acids, which could not at present be satisfactorily explained in terms of our conventional symbols; in like manner, it was conceivable that open-chain compounds might exist having properties very different from those of the known allyl-derivatives.

Dr. Perkin, Sen., said that in their physical properties the compounds discovered by his son were altogether peculiar: they behaved nearly as saturated bodies, and therefore the only way at present of representing them was to employ closed-chain formulæ. The maleic compounds behaved as unsaturated bodies, and the fumaric compounds were still further removed from saturated compounds. The properties of the tetramethylene compounds were in no sense akin to those of the maleic-fumaric, or citra-ita-mesaconic series.

Dr. Perkin, Jun., said that in the paper referred to he had only sought to prove that allylacetic and allylmalonic acids were different from what he had termed tetramethylene mono- and dicarboxylic acids; the latter might have some quite different formulæ to those which he had proposed, but they could not be regarded as parallel compounds to the fumaric or itaconic acids.

Dr. Armstrong added that it must not be forgotten that trimethylene, $CH_2{\cdot}CH_2{\cdot}CH_2$, although unsaturated, behaves practically as a saturated compound.

9. "*The Decomposition of Potassium Chlorate and Perchlorate by Heat.*" By Percy F. Frankland, Ph.D., B.Sc., A.R.S.M., and John Dingwall.

The authors have re-investigated the points in the decomposition of these bodies which were raised by Teed (*Proc. Chem. Soc.*, Nos. 12 and 16, 1885-86).

In the first series of experiments potassium chlorate was partially decomposed by heating in a tube over a naked flame. The results are summarised in Table I.

In further experiments the potassium chlorate was decomposed at a temperature below that at which potassium perchlorate suffers change, by heating it in the vapour of boiling sulphur. (See Table II.)

It appears, therefore, that when potassium chlorate is partially decomposed by heat, the decomposition may be expressed by equations of the type—

$$8KClO_3 = 2O_2 + 5ClO_4 + 3KCl,$$

and that the more complete the decomposition the more does it approximate to that indicated by the equation $2KClO_3 = KClO_4 + KCl + O_2$.

The authors have fully established the formation of potassium chlorate in the first stages of the decomposition of potassium perchlorate. This reaction is of interest as forming an exception to Berthelot's law of maximum work, the well-known formation of potassium perchlorate from potassium chlorate being a reversible reaction.

In a first series of experiments with perchlorate, the potassium chlorate was determined by means of the zinc-copper couple method. Finding, however, that the sample had a very slight action on perchlorates, a second series of experiments were made, in which the chlorate formed was determined by evaporation with chlorhydric acid; the results entirely substantiate those of the first series, and are as shown in Table III.

10. "*The Action of Chlorine on Methyl Thiocyanate.*" By Dr. J. William James, University College, Cardiff.

The author describes the result of the action of chlorine on methyl thiocyanate, a reaction first studied by Cahours, and afterwards by Riche.

On passing dry chlorine into methyl thiocyanate at the ordinary temperature, to complete saturation, the reaction being completed in sunlight, methyl thiocyanate is decomposed into *cyanuric chloride*, *thiocarbonyl chloride* ($CSCl_2$), and the *tetrachloride*, $CSCl_4$. The latter is identical with the perchlormethylmercaptan of Rathke, obtained by the action of chlorine on carbon disulphide in presence of iodine. The chief reaction which takes place is—

$$3CH_3SCN + 11Cl_2 = C_3N_3Cl_3 + 2CSCl_4 + CSCl_2 + 9HCl.$$

Cahours studied the reactions in a qualitative manner only; and Riche did not show the presence of ether thiocarbonyl chloride or tetrachloride, and, moreover, obtained a body of the formula C_2SCl_6, which, as is shown, must have been a mixture of $CSCl_4$ and $C_3N_3Cl_3$.

The author has further established, that when chlorine is passed into thiocarbonyl chloride, it is completely absorbed, forming thiocarbonyl tetrachloride; and that by the prolonged action of the gas this latter substance is decomposed into carbon tetrachloride and sulphur dichloride.

The well-known fact that carbon disulphide is converted by chlorine into these two bodies seems now to be the result of a series of reactions, viz.: (1) $CS_2 + 2Cl_2 = CSCl_2 + SCl_2$; (2) $CSCl_2 + Cl_2 = CSCl_4$; (3) $CSCl_4 + Cl_2 = CCl_4 + SCl_2$.

At the next meeting, on February 17th, the following papers will be read:—

Table I.

Percentage of oxygen evolved on weight of $KClO_3$ taken.	On $KClO_3$ actually decomposed. Percentage of oxygen evolved.	KCl formed (per cent.)	$KClO_4$ formed (per cent.)	Proportion of oxygen evolved to 74·57 parts of KCl formed.
No. 1. 2·66	6·30	22·48	71·22	20·87
No. 2. 5·19	6·27	22·43	71·30	20·84
No. 3. 6·47	7·09	23·68	69·23	22·32
Equation—				
$10KClO_3 = 6KClO_4 + 4KCl + 3O_2$ requires . .	7·83	24·34	67·83	24·00
$8KClO_3 = 5KClO_4 + 3KCl + 2O_2$ requires . .	6·53	22·81	70·66	21·33
$2KClO_3 = KClO_4 + KCl + O_2$ requires	13·05	30·42	56·53	32·00

Table II.

Percentage of oxygen evolved on weight of $KClO_3$ taken.	On $KClO_3$ actually decomposed. Percentage of oxygen evolved.	KCl formed (per cent.)	$KClO_4$ formed (per cent.)	Proportion of oxygen evolved to 74·57 parts of KCl formed.
No. 1. 6·80	8·14	25·44	66·42	23·88
No. 2. 6·78	8·76	26·03	65·21	25·10
No. 3. ($KClO_3$ mixed with powdered glass) 14·30	15·34	33·55	51·11	34·10

Table III.

Percentage of oxygen evolved on weight of $KClO_4$ taken.	On $KClO_4$ decomposed. Oxygen evolved (per cent).	KCl formed (per cent).	$KClO_3$ formed (per cent).	Oxygen evolved to 74·57 parts of KCl formed.
No. 1. 6·34	36·54	38·70	24·76	70·41
No. 2. 7·80	36·63	38·79	24·58	70·42
No. 3. 24·05	43·60	49·21	7·19	66·06
The equation—				
$7KClO_4 - 2KClO_3 + 5KCl + 11O_2$ requires . .	36·29	38·44	25·27	70·40

"The Influence of Temperature on the Heat of Dissolution of Salts," by S. U. Pickering.

"Researches on the Laws of Substitution in the Naphthalene Series" (Part III.), by Dr. Armstrong.

CORRESPONDENCE.

ON THE COMPOSITION OF HYDRATED SALTS.

To the Editor of the Chemical News.

Sir,—I have done my utmost to simplify the question of hydrates, but Mr. Pickering cannot make up his mind to face it. A fortnight ago he used the words "*galli cantus*," to-day "Arcadian simplicity."

I cannot continue any longer a discussion on a subject of such very great simplicity. I hope that English chemists will not lose the chief point, viz., the determination not to desiccate properly, 1st, the alum under examination, by means of a large mass of very dry alum. I repeat that the alum remains perfectly transparent up to the last moment (constant weight) with this method of desiccation, and that, if it is then put under a shade with sulphuric acid, one hour afterwards the crystals have a whitish appearance at the angles: this is the commencement of dehydration. 2nd. The same must be done in the case of sulphate of magnesia.—I am, &c.,

E. Maumené.

COHESION AND SUBMERSION FIGURES: THE NATURE OF SOLUTION.

To the Editor of the Chemical News.

Sir,—The reference to me in the Chemical News (vol. lv., p. 1) calls for a few remarks on my part. As far as I was aware at the time of writing, each of my notes on "Cohesion and Cohesion Figures" (Chemical News, vol. liv., p. 58) contained at least one original idea. I do not remember to have read of such a thing as a solidified vortex ring before, or of a comparison such as I make of the life-history of liquid and gaseous vortex rings with a view to showing their possible identity. I drew this analogy some years ago in the first issue of *Science for All* (vol. iv., p. 200), where I refer to Mr. Tomlinson, who is acknowledged to be the British authority on this subject, as his paper in the Chemical News (vol. lv., p. 1) well shows.

Nor do I remember to have before seen laid down the connection between cohesion and solution. The notes 1 and 2 (Chemical News, vol. liv., p. 58), on "A Law of Solubility" and "Its Connection with Mendeleeff's Periodic Law" were written by me before any advertisement had appeared of the proposed 1886 B.A. "Discussion of the Nature of Solution." Three weeks after their publication Dr. Tilden's letter appeared in your columns, indicating the general nature of the subjects upon which he intended to offer remarks, and one of the headings was "Is there any general connection between solubility and atomic weight in a series of compounds in which only one constant varies?" (Chemical News, vol. liv., p. 95). This was the subject of my note 2, where I show that in one natural series of compounds, the chlorides of Mendeleeff's Group I., as the atomic weight of the variable decreases the solubility of the compound in water increases; and one may imagine, as a working hypothesis, that if water had had a greater molecular weight than the heaviest of this series the relation would have been a direct instead of an inverse one. In the following September the relation of kinship to solubility was dwelt upon at the B.A. meeting, according to the reports in your columns. Dr. Tilden pointed out that the salts containing water of crystallisation, as resembling water, are for the most part soluble in water (Chemical News, vol. liv., p. 183), and Dr. Armstrong gave many cases of like

dissolving like (Chemical News, vol. liv., p. 218) which are illustrative of the law I formulated in my prior note 1.

I am aware that coincidences of this kind are common (*vide* Chemical News, vol. liv., p. 239), and I request leave to point them out in the present instance because my terse notes give no idea of the time and thought I have expended on the subject since 1877, and I would not have them ignored because of their terseness.—I am, &c.,

William Ackroyd.

Borough Laboratory, Halifax,
January 29, 1887.

ALKALI—CALIFORNIA.

To the Editor of the Chemical News.

Sir,—Mr. Beauchamp has brought to me two or three samples of the efflorescence from the soil in California. It is sodium sulphate, or thenardite, more or less pure. I fear it is of very little value at present.—I am, &c.,

John Attfield.

17, Bloomsbury Square,
February 5, 1887.

VAPOUR DENSITY.

To the Editor of the Chemical News.

Sir,—Victor Meyer's method of determining vapour densities is recommended for its simplicity, accuracy, and suitability for liquids of both high and low boiling-points. But in attempting to make determinations of the vapour densities of volatile bodies, as chloroform, I find it impossible to prevent the water of the trough from rushing into the tube during vaporisation of the body experimented upon.

Would someone of experience indicate the cause, and therefore the prevention, of this source of error and annoyance?—I am, &c.,

J. W. S.

New Mills, February 6, 1887.

PYROMETRIC MEASUREMENTS OF HIGH TEMPERATURES.

To the Editor of the Chemical News.

Sir,—Referring to MM. Ch. Lauth and G. Vogt's indicators of temperature, "Fusible Watches" (Chemical News, vol. lv., p. 47), I used similar indicators twenty-eight years ago, to determine temperatures when baking ultramarine mixtures. My indicators were composed of litharge, pipeclay, lime, and borax, finely ground; the mixture after moistening with water being formed into small cones, and, after drying, partially baked. I found that they gave most reliable results.—I am, &c.

M. A. Gage.

Rhuddlan, Flintshire, Feb. 8, 1887.

THE ANALYSIS OF OPIUM.

To the Editor of the Chemical News.

Sir,—Mr. Stillwell's method for the estimation of morphia in opium, as described in the Chemical News (vol. lv., pp. 41 and 54), is very similar in most respects to one which has been employed in my laboratory for the same purpose during the past year.

The essential points of difference are—(1), the degree of concentration of the opium solution—Mr. Stillwell evaporating the fluid to a somewhat smaller bulk than I consider necessary; (2), the strength of the ammonia solution employed for precipitating the morphia—Mr. Stillwell using ammonia of 0·960 sp. gr., whereas I use a *smaller quantity* of strong ammonia, sp. gr. 0·880; and, (3), instead of purifying the weighed morphia by means of hot alcohol, I check my results by titrating the precipitate with decinormal sulphuric acid. The titration with acid generally gives figures from 0·10 to 0·25 per cent lower than those obtained by simply weighing the morphia.

I can highly recommend Mr. Stilwell's method, as it may be relied upon to extract *all* the morphia present, which most other processes fail to do; and the morphia obtained is also much purer than that yielded by any other with which I am acquainted.—I am, &c.,

Rowland Williams.

9, Albert Square, Manchester, Feb. 7, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chemie.
Fifth Series, Vol. xiv., No. 12, December 15, 1886.

On an Epidemic of Micrococcus prodigiosus.—M. Grimbert.—The author had the opportunity of examining some cooked meat covered with carmine spots, which smeared off on touching. They were due to a microbian vegetation capable of being planted in other organic matter, *e.g.*, boiled potatoes. The colouring-matter is very soluble in alcohol, ether, chloroform, and carbon disulphide. The spectroscopic examination of the alcoholic solution showed a well-marked absorption-band between the rays D and E, and then a feebler band near the ray *b*, and a gradual extinction of the other colours up to the violet.

Areometric Determination of the Alcohol in Wines. Vinodensimeter.—A. Bouriez.—Already noticed.

Vol. xv., No. 1, January, 1887.

Assay and Analysis of Officinal Quinine Sulphate.—E. Jungfleisch.—In this first memoir the author criticises the process laid down in the French codex, and states that its sensitiveness is so much the greater as the sample is dissolved at a higher temperature. He recommends 100°. He does not approve of the optical test unless the absolute purity of the quinine used in medicine is to be insisted upon.

Decomposition of Oiled Silk and Oil Paintings.—M. Balland.—Already noticed.

Preparation and Examination of Acetanilide.—M. Yvon.—This paper has merely a pharmaceutical interest.

Internal Hygiene of Houses illuminated by the Electric Light.—Dr. Sambuc.—The author refers to glow-lamps worked by means of the Grevet battery. To prevent mischief he recommends that cells of porcelain or stoneware should be used for the batteries, that the sulphuric acid should be diluted and let cool before immersing the zinc, that the depolarising agent should not be mixed with the exciting liquid, that the zinc should be of good quality, free from arsenic, and well amalgamated, and that the battery should be fixed in a garden, a court, or a cellar.

Sensitiveness of Some Reagents for Albumen.—M. Simon.—The most sensitive reagent is that of Méhu, a mixture of 1 part crystalline phenic acid with one part acetic acid and 2 parts water.

On the Alleged Soluble Starch.—J. Kraus.—The substance found in the epidermis of *Ornithogala* and *Gagea*, although it is coloured blue by iodised water, is not a starch, and should rank near the tannins. The reaction with iodine is not surprising, since Giessmayer has shown that solution of tannin in a slightly alkaline liquid gives a bright red colour with a weak solution of iodine.

Nasse has shown that tannin, gallic, and pyrogallic acids, liberated in presence of neutral or acid salts, is turned a reddish purple by iodine.

Chemical and Pysiological Study of Methylal.—E. Personali.—Methylal is a novel hypnotic agent of the composition $C_3H_8O_2$.

Distinctions between the Colourations of Urine by Chrysophanic Acid and by Santonine.—M. Hoppe-Seyler.—These colourations may be distinguished by adding to the urine caustic soda, and then agitating with amylic alcohol. If the colouration is due to santonine the colouring-matter passes almost entirely into the solvent, and the urine is decolourised. If it is derived from chrysophanic acid the amylic alcohol takes up mere traces and the urine remains red. But if the urine is acidulated, the chrysophanic acid may be removed by amylic alcohol, and if the solvent is then shaken up with ammonia the aqueous stratum is reddened. Under the same circumstances the colouring-matter of santonine is not removed. The absorption spectrum of the two colours likewise differs.

Poisoning by the Vapour of Benzoline.—M. Foulerton.—From the *Lancet*.

Detection of Salicylic Acid in Beer and Wine.—M. Rose.—From the *Journal of the Chemical Society*.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxvi., Part 3.

Experimental Examination of the Older and the More Recent Formulæ of Dispersion.—J. W. Bruehl.—The author concludes that none of the formulæ deduced either from the older or from the more recent theories gives the true expression of the law acting in nature. All are applicable up to a certain degree, and all break down if we attempt to apply them beyond a certain limit.

Synthetic Experiments with Acet-Acetic Ester.—L. Knorr.—In this second communication the author discusses the conversion of diacet-succinic ester and acet-acetic ester into derivatives of pyrrol. The readiness with which the components coalesce to form the pyrrol ring seems to the author to afford evidence of the stability of this peculiar arrangement of atoms, as appears, indeed, from the numerous pyrogenous modes of formation.

Phenazine as the Fundamental Substance of the Colouring Matters of the Toluylen-Red Group.—August Bernthsen and Hugo Sweitzer.—Among the most interesting results of recent chemical investigation must rank our recognition of the fact that there exist certain so-called "ring-shaped" groups of atoms, like those of benzol, naphthaline, anthracene, and pyridine, which are widely distributed and which are formed with exceptional readiness. Among these a peculiar interest attaches to that ring which exists in anthracene, and which is characterised by having two phenylen groups connected by two groups of atoms, which, in the benzol residues, take up the ortho-position to each other, so that with the carbon atoms in question they form a third ring of six members. Two compounds analogous to anthracene, acridine and thiodyphenylamine, have been investigated in the Heidelberg laboratory. These compounds, like anthracene, produce beautiful colouring-matters; thus chrysaniline is a diamido-phenylacridine, and thiodiphenylamine passes, by the intussusception of amido groups or hydroxyles, into the leuko-compounds of colouring-matters of which methylene-blue is the most prominent representative. Hence it seemed to the authors desirable to examine if other diorthodiphenylene derivatives are capable of existence, and if they also are chromogens. Such a body is phenazine. The authors prove that methylphenazine and phenazine are not merely chromogens, but actually give rise to colouring-matters of importance. The safranines (which contain one phenyl group more than the colouring matters of the toluylene-red group) must be referred to a phenyl derivative of phenazine, or rather of hydrophenazine.

Bulletin de l'Association des Elèves de M. Fremy.
Series 2, No. 7.

The Recruitment of Science.—E. Fremy.—In this important address the author summarises his former memoirs on experimental instruction in chemistry; reform in higher scientific instruction; abandonment of scientific careers; the recruitment of science; cast-off savants; the volunteers of science; the organisation of scientific careers and scientific attachés. Of a considerable class of youths he writes that the nature of their minds led them to cultivate science, but instead of this tendency being developed they receive an instruction mainly literary. They might have become savants, but they are made into lawyers and journalists.

Researches on Ramie.—E. Fremy.—From the *Comptes Rendus*.

Action of an Electric Current upon Anhydrous Hydrofluoric Acid.—H. Moissan.

Decomposition of Hydrofluouic Acid by an Electric Current.—H. Moissan.

New Experiments on the Decomposition of Hydrofluoric Acid by an Electric Current.—These papers are reproduced from the *Comptes Rendus*, and have been already noticed.

Influence of Foreign Matters upon the Qualities of a Metal.—Prof. W. Chandler-Roberts.—An abstract of a lecture delivered in London.

Determination of Glycerin.—W. Fox and J. A. Wanklyn.

Revue Universelle des Mines, de la Metallurgie, &c.,
Vol. xx., No. 2, September and October, 1886.

New Calcium Phosphate.—G. Hilgenstock.—Crystals obtained from the slags of the Thomas and Gilchrist process were found to be a tetrabasic calcium phosphate.

Note on the Crystals derived from the Thomas and Gilchrist Slag.—A. de Groddack and Dr. K. Brockmann.—A crystallographic account of the compound described in the foregoing paper.

Volumetric Determination of Sulphur in Sulphides Decomposable by Hydrochloric and Sulphuric Acids.—Fr. Weil.—Already noticed.

A Procedure for the Direct Separation of Manganese and Iron.—L. Blum.—Noticed under *Zeitschrift f. Anal. Chemie*.

MEETINGS FOR THE WEEK.

MONDAY, 14th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Building Materials," by W. Y. Dent, F.C.S.
TUESDAY, 15th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
—— Pathological, 8.30.
—— Society of Arts, 8. "Some of Our Colonial Woods," by Allan Ransome.
WEDNESDAY, 16th.—Society of Arts, 8. "Uses, Objects, and Methods of Technical Education in Elementary Schools," by Henry H. Cunynghame.
—— Meteorological, 7.
THURSDAY, 17th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— London Institution, 6.
—— Royal Institution, 3. "Molecular Forces," by Prof. A. W. Rücker, F.R.S.
—— Chemical, 8. Ordinary Meeting.
FRIDAY, 18th.—Royal Institution, 9. "Genesis of the Elements," by William Crookes, F.R.S.
—— Geological, 1. (Anniversary).
SATURDAY 19th.—Royal Institution, 3. "Modern Composers of Classical Song—Jensen, Lassen, Holstein, Berlioz, and Wagner," by Carl Armbruster.

THE CHEMICAL NEWS.

VOL. LV. No. 1421.

CONTRIBUTIONS TO THE METALLURGY OF BISMUTH.*

By EDWARD MATTHEY, F.C.S., Assoc. Roy. Sch. Mines.

§ 1. *Bismuth: its Separation from Gold, and its Refining Action upon same during the Process of Separation.*—In bringing the above subject under notice, it is necessary to allude to some of the facts distinguishing this very interesting metal.

Bismuth, in some of its important characteristics and reactions, resembles lead. And one of the chief points of resemblance between these metals is their ready oxidation, and their absorption by bone-ashes or wood-ashes whilst so oxidised. I refer, of course, to the process of cupellation.

This ancient and serviceable process, still employed universally for the separation of gold and silver from lead, is equally applicable to bismuth, if associated with these precious metals; and, like lead, bismuth may be readily employed as a vehicle or means of collecting gold and silver from their ores in reduction processes; but its comparative cost accounts for its non-employment in this respect.

Commercially speaking, bismuth differs from lead in its greater value, lead being worth at present £13 to £14 per ton,† whilst bismuth realises between £700 and £800 per ton; this high value being due to its greater rarity and to its limited and special uses.

As is well known, bismuth ores are frequently auriferous; and one of the points which it is my desire to bring under notice is the effectual separation of the gold from bismuth by a rapid and efficacious process.

Of course, nothing could be easier than to separate these two metals by the ordinary process of cupellation. The gold, by these means, is at once rendered available, but with the drawback that not only is there a very considerable loss of bismuth by volatilisation during the cupellation, but the subsequent recovery of the metal, which in the state of oxide has been absorbed by the cupel, is rendered necessary, involving a tedious and troublesome smelting operation, the employment of expensive fluxes, and a further considerable loss of metal.

Bearing in mind the close resemblance of bismuth to lead in its behaviour in the cupellation process, I directed my attention to its separation from gold by means of the addition of a small proportion of zinc—a method known as the Parkes process, as employed for the separation of silver from lead. And this I found successful, the natural separation of these two metals during the process of cooling proving to be similar in both cases.

The operation is carried out by me as follows:—

The bismuth holding the gold is melted at the ordinary temperature, about two per cent of melted zinc is then added, and the whole brought to a dull red heat. The alloy is then well stirred, and the temperature gradually lowered. When at a black heat the slight crust formed on the surface is skimmed off and the metal again treated with a further quantity of zinc at the higher temperature. *The whole of the gold* will be found in these skimmings, and the bismuth will be thus freed from it.

The skimmings, consisting of bismuth, gold, and zinc, and zinc oxide, I now treat by a process which quickly renders the gold available, and at the same time has the effect of *refining* the gold from all impurities excepting silver during the actual process of extraction.

This small proportion of bismuth litharge and its charge of gold is fused in a clay crucible with a little borax, and allowed to cool down in the crucible, or it is poured into a mould with the bismuth litharge, which being perfectly liquid, allows the metallic gold to separate by its own gravity, and during its fusion absorbs any base metals associated with it as oxides. *The bismuth litharge, in fact, acts as a refining agent to the gold*, which, when cold, is detached from it. This bismuth slag is broken up, refused with a little metallic bismuth, and is so freed from the last trace of gold which is collected by the bismuth, and subsequently extracted. The bismuth litharge so freed from gold is then reduced by fusion with carbon to its metallic state.

The quantity of bismuth litharge holding the gold is exceedingly small in proportion to the bulk of metal originally treated, as the figures hereinafter given will show; but, by this process the bismuth is at once freed from its gold contents with little time, labour, or expense.

I have continuously carried out this method of treatment with the most satisfactory results. It will only be necessary to take the figures of one operation as an illustration.

A quantity of 9483 lbs. of bismuth, holding about one per cent of impurity, and 12·5 ounces of gold per ton (equal to 53·5 ounces in the bulk), was so treated, and of this nearly 9000 lbs. was immediately rendered available for commercial use, the skimmings, which amounted to 658 lbs. (7·30 per cent of the bulk), *containing the whole of the gold.*

These skimmings I oxidised by means of nitric acid, thus obtaining the greater proportion of the bismuth and what little copper there was in solution, from which the bismuth was precipitated by the ordinary method, care being taken to saturate the nitric acid by extracting the greater portion of the bismuth as nitrate, so as to leave a portion of the bismuth as oxide with the gold in order to refine it from the impurities existing as oxides when fused with it. This residue, collected and dried, was, when dried, fused in clay crucibles, with a small quantity of borax, yielding the full amount of gold shown by assay.

As before stated, in these fusions the metallic gold separates from the bismuth litharges, and descends to the bottom of the crucible by its own gravity. The liquid and supernatant bismuth litharge floats upon it and breaks away readily when cold, the gold so obtained being associated only with silver, both metals being in fact *refined by the action of the bismuth litharge.*

§ 2. *Separation of Bismuth from Lead.*—The difficulty surrounding the treatment of bismuth associated with other metals by any rapid or comprehensive process is well known to the metallurgical chemist. I believe I am correct in stating that hitherto the only process employed for the refining of bismuth on the Continent—notably in Saxony, the chief continental source of this metal—has been that of chlorination and subsequent precipitation, a process tedious in itself, and involving much plant and labour in comparison with the quantities of metal operated upon.

Rapidity of production with a minimum margin of loss, in order to free the metal from its impurities and render it marketable as quickly as possible, being a great desideratum, induced me to turn my attention to its refining by dry processes. In carrying this out I have found present most of the metals which are easily seized by and become associated with the bismuth itself during the process of reduction from its ores,* such as antimony, arsenic, tellurium, lead, copper, &c., all of which I have successively and successfully dealt with.

It is not my intention in this paper to describe the processes adopted for the elimination of these several metals, but to confine myself to the separation of lead, the presence of which especially presented at first great difficulties.

* A Paper read before the Royal Society, Feb. 10, 1887.

† June, 1886.

* See Table of Analyses herewith.

As stated above, I have found that I can separate one by one the metals mentioned above, all of which have been associated with crude bismuth which has come under my notice. In this, success though gradual has been complete; but I was still confronted by the fact that the lead alloy was retained by the bismuth with a most characteristic persistency, which seemed to defy all efforts of separation excepting by tedious wet or acid processes.

The amount of lead existing in the bismuth I operated upon, after freeing it by dry processes from its other impurities, varied from 2 to 10 per cent.

Bearing in mind the respective fusing-points of lead and bismuth, it occurred to me that, as alloys of bismuth and lead fuse at a temperature considerably lower than that of bismuth itself, separation would possibly take place between the two metals at a certain point of cooling: I therefore made the following experiment:—

Taking a quantity of bismuth (about 10 cwts.), holding 11·5 per cent of lead, and fusing same, I allowed the metal to cool until the major part of it had crystallised, then removing the fluid portion.

The residue showed by assay only 6·35 per cent of lead, pointing at once to the partial separation I had hoped for.

These crystals again similarly treated showed only 3·75 per cent of lead.

The operation repeated gave crystals with only 2 per cent of lead, and a fourth crystallisation brought this down to below 0·5 per cent.

As a matter of possible interest I subjoin the progressive results during the crystallising operations of several lots up to the point of bulking, and of finally separating every trace of lead:—

Bismuth holding 14·6 per cent Lead.

1st	crystallisation gave crystals holding	9·8	p. c. of lead.
2nd	,, ,,	5·1	,,
3rd	,, ,,	3·8	,,
4th	,, ,,	2·5	,,
5th	,, ,,	0·4	,,

Bismuth holding 12 per cent Lead.

1st	crystallisation gave crystals holding	6·2	p. c. of lead.
2nd	,, ,,	4·2	,,
3rd	,, ,,	1·4	,,
4th	,, ,,	0·4	,,

Bismuth holding 7·6 per cent Lead.

1st	crystallisation gave crystals holding	4·8	p. c. of lead.
2nd	,, ,,	3·8	,,
3rd	,, ,,	0·8	,,
4th	,, ,,	0·4	,,

Bismuth holding 11 per cent Lead.

1st	crystallisation gave crystals holding	5·5	p. c. of lead.
2nd	,, ,,	2·5	,,
3rd	,, ,,	1·0	,,

Bismuth holding 5·6 per cent Lead.

1st	crystallisation gave crystals holding	2·0	p. c. of lead.
2nd	,, ,,	0·7	,,
3rd	,, ,,	under 0·5	,,

Bismuth holding 5·3 per cent Lead.

1st	crystallisation gave crystals holding	1·8	p. c. of lead.
2nd	,, ,,	0·6	,,
3rd	,, ,,	under 0·5	,,

Having attained this point, I worked upon several large quantities of metal—with practically the same results—finally succeeding by a continuation of the process in eliminating every trace of lead.

By the above it will be seen that the process becomes an exceedingly simple one, large quantities being treated at one time, involving little or no loss, and occupying hours, instead of possibly weeks.

To illustrate the facilities of the separation of lead and bismuth alloys, I give the following figures from metal holding originally five per cent of lead.

10,675 lbs. produced, in the course of six to seven crystallisations, 9306 lbs. of available bismuth, the residue 1118 lbs. holding 40 per cent of lead, so that from a quantity of nearly five tons of bismuth and lead allow only about half a ton remained, holding practically the whole of the lead; the bulk of the bismuth separated by simple crystallisation holding traces only of lead, which, if necessary, could be readily eliminated by further crystallisation. From these facts it is apparent that the separation of these two metals can be effected by turning to account their *relative fusing points.*

Recapitulation of foregoing Experiment.

10,675 lbs. leady bismuth, holding five per cent lead, yielded 9306 lbs. of good commercial bismuth by the crystallisation process, or within six per cent of the total contents of pure bismuth.

Leaving for subsequent treatment—

Of alloy, holding 40 per cent of lead, 1188 lbs., which is equal to 11·13 per cent of the whole weight of metal treated.

Average Analysis of the Bismuth Ores worked upon.

Bismuth	44·57
Lead	2·35
Antimony	0·64
Arsenic	1·26
Moldbdenum	5·02
Tellurium	0·17
Iron	5·25
Manganese	0·05
Copper	0·24
Tungstic acid	2·45
Alumina	0·18
Magnesia	0·09
Lime	0·81
Carbonic acid	1·47
Sulphur	3·77
Insoluble earthy matter, chiefly silica	23·12
Water	3·37
Oxygen in combination and loss	5·19
	100·00

SEPARATION OF MERCURY AND PALLADIUM FROM EACH OTHER AND FROM LEAD, COPPER, AND BISMUTH.

By TH. ROSENBLADT.

The behaviour of the alkaline thiocarbonates to certain sulphides of the IV. and V. group is remarkable, and especially to the metals which form complicated ammonium compounds, *i.e.*, cobalt, nickel, mercury, and palladium. These sulphides dissolve in potassium thiocarbonate in considerable quantities, so that this solubility can be utilised both in qualitative and quantitative determinations. From a thiocarbonic solution of palladium and mercury, the latter only is precipitated by carbonic, whilst the palladium remains in solution.

The author explained in the *Journal of the Petersburg Chemical Society* for 1885 how cobalt and nickel sulphides can be easily separated by potassium thiocarbonate from the remaining sulphides of the IV. and from the hydrates of the III. group.

In analogy with these investigations he has now applied the reagent in question to the V. group, the results of which experiments are here laid down. Potassium thiocarbonate solution (or, briefly, thiosolution) is prepared

by dissolving 1 part of sulphur in 2 parts of carbon disulphide, adding 15 parts caustic potash lye of sp. gr. 1·13, and digesting the mixture for some days in a glass bottle with frequent shaking, until the liquid takes an orange colour. It is then decanted off, and the residue is again treated with 8 parts of potash lye. If the carbon disulphide in the bottle appears colourless more sulphur must be dissolved and the liquid obtained can be used for the further preparation of the reagent. The orange liquids obtained are poured together, allowed to settle, filtered, and are then ready for use.

On mixing solutions of mercuric and palladium chloride and heating them with thio-solution in a beaker, the result is a clear liquid without sediment. Through this solution there is passed washed carbonic acid until all the mercury sulphide is precipitated. The deposit is placed in a double filter, previously dried at 101°, washed sufficiently, and freed from sulphur by treatment with carbon disulphide in a Soxhlet apparatus. The filtrate, after treatment with carbonic acid, is mixed with hydrochloric acid until it has an acid reaction. On the application of heat palladium sulphide is, in course of time precipitated, collected on a filter, washed, dissolved in *aqua regia*, the excess of acid is evaporated off, the residue is taken up in water, filtered, almost neutralised with sodium carbonate, a sufficiency of solution of mercuric cyanide is added, and a gentle heat is applied until the liquid no longer smells of cyanogen. The precipitate is collected, washed, dried, strongly heated in a Rose's crucible (previously tared), and finally let cool in a current of hydrogen.

In a corresponding manner mercury may be separated from lead, copper, and bismuth, but not from cadmium. Mixtures of mercury and silver may also be separated from the same metals.—*Zeitschrift Analyt. Chemie* (vol. xxvi., p. 15).

THE APPLICATION OF OXALIC ACID FOR THE SEPARATION OF VARIOUS METALS.

By C. LUCKOW.

If oxalic acid is added to the solutions of different common metals—neutral or faintly acid—there are produced in the majority of such solutions precipitates of insoluble or sparingly soluble oxalates. In a few cases only there takes place no separation of insoluble oxalates, and the solutions remain clear.

This latter case occurs in the solutions of the alkali-metals, and those of the higher compounds of some metals rich in electro-negative constituents, in which hydrated alkalies throw down hydrates corresponding to the sesqui- and peroxides, and in which such hydrates form compounds with a metallic acid. A precipitation of insoluble oxalates does not occur in the solutions of neutral salts of the alkaline metals, and in the solutions of chrome, aluminium, iron, manganese, uranium, and tin oxides, as well as of chromic, manganic, and antimonic acids, and of the acids of arsenic.

This behaviour of the oxalates affords means not only of distinguishing the various stages of oxidation of the above acids, but also of separation, qualitatively and quantitatively, of the metals in question in their higher compounds from a great number of other metals. Setting aside gold and platinum we find that among the metals of group VI. stannous oxide and antimony teroxide are separated from their solutions by oxalic acid, whilst no precipitation ensues in the solutions of stannic oxide, antimonic acid, and of the arsenic acids. All the metals of group V. are precipitated by oxalic acid. The oxalates of lead, bismuth, silver, copper, and mercury, both in their maximum and minimum compounds, are almost insoluble; cadmium oxalate is sparingly soluble. Copper, and indeed all other metals, should be thrown down only from hot liquids, preferably by a boiling solution of oxalic acid, or by adding to the boiling solution a sufficiency of finely-pulverised oxalic acid, as the precipitates in boiling solutions subside more rapidly. After the liquid has become clear it is filtered by decantation, so that the least possible quantity of the precipitate is brought upon the filter. The two portions of precipitate (that on the filter and that on the beaker) are then dried, placed in a porcelain crucible, and heated, very cautiously at first, and finally more strongly after the addition of a little nitric acid. Small quantities of copper oxide can be easily converted into oxide; large quantities are inconvenient on account of the gases evolved during the decomposition of the oxalates, which may occasion loss by projection.

The silver salt enters into decomposition at 110°, and detonates if heated more strongly. The mercuric salt is decomposed at 163° somewhat violently into mercurous salt and carbonic acid. Instead of decomposing oxalic acid in its salts by heat alone, it may be destroyed by heating with strong sulphuric or phosphoric acid, with permanganic acid, chromic acid, or with chlorine in an alkaline solution.

As for the metals of group IV., oxalic acid throws down nickelous, cobaltous, manganous, ferrous, and uranous oxides, and also zinc oxide from their neutral or moderately acid solutions as sparingly soluble oxalates. In this group, consequently ferrous, manganous, and uranous oxides may be separated, by means of oxalic acid, from the corresponding higher oxides. The faintly rose-coloured cobalt oxalate and the dull green nickel oxalate much resemble the copper salt in the fineness of the precipitates. Both are very sparingly soluble. Rather more soluble is the lemon-yellow, very stable ferric oxalate, and the manganous salt, which is almost white and settles readily.

The zinc salt is most readily and completely separated by evaporating its solutions mixed with a slight excess of oxalic acid. This behaviour of the zinc salt must be kept in mind in quantitative analyses. The complete separation of all the precipitates produced by oxalic acid is much promoted by the time allowed. The metals of group IV. require more time than those of group V. If to the solutions supersaturated with oxalic acid acid there is added a solution of ammonium chloride or nitrate, the separation of the insoluble oxalates is much promoted. A rapid and complete separation of all these salts is effected by evaporating down the solution with a slight excess of oxalic acid, and taking up the soluble matters in a little water. A volatilisation of volatile chlorides under these circumstances does not take place if oxalic acid is present in excess, even in case of arsenious compounds. Dilute sulphuric and nitric acids do not appreciably increase the solubility of oxalates which are insoluble in pure water, and in dilute oxalic acid. Hydrochloric acid, even if dilute, has a decidedly solvent action. Similar is the action of strong oxalic acid upon various insoluble oxalates. Many of the insoluble oxalates combine with the alkaline oxalates to form soluble double salts. Exceptions are the strontium, barium, calcium, silver, lead, and mercurous salt. The lead and the mercuric salt dissolve in hot solutions of alkaline oxalates, but separate out again on cooling or dilution. The barium, magnesium, and mercuric salts are soluble in ammonium chloride. The non-volatility of the soluble oxalates is of importance, as evaporation is the quickest, simplest, and most certain method of separating the soluble compounds quantitatively from the insoluble. In such solutions the oxalic acid must be present in slight excess. If the evaporated residue is treated with water the soluble oxalates are dissolved without decomposition, and may then be separated from the insoluble by filtration.

Ammonia produces no precipitates in the solutions of antimonic and antimonious acids, whilst precipitates of oxides or of basic salts are formed in the oxalic solutions of stannic, ferric, uranium, chromium, and aluminium oxides. Alkaline phosphates and borates, which, like

ammonia, precipitate all these solutions in the absence of oxalic acid, occasion no deposits in its presence. This behaviour of tin and antimony solutions with ammonia affords a simple means for the separation of the two metals. Even in solutions containing both the tin is thrown down free from antimony if the solution contains sufficient oxalic acid or ammonium oxalate, or if the precipitated tin oxide is dissolved in hydrochloric acid, mixed with oxalic acid, and re-precipitated with ammonia.

If we have to examine an alloy of tin, or antimony, or of both, with lead, copper, zinc, or iron, the comminuted sample is dissolved in a small excess of aqua regia, oxalic acid is added to the boiling solution so long as a precipitate is produced, the insoluble oxalates are allowed to settle on cooling, or the solution along with the precipitate is evaporated to dryness on the water-bath and taken up again in a little water. The separation of the precipitate from the liquid is best effected by decantation through a double filter, bringing upon the filter as little as possible of the precipitate. In quantitative operations the precipitate and the filter are freed from soluble portions by means of a dilute solution of oxalic acid, and both are then dried and cautiously ignited. In the solution are found the tin, iron, and antimony if its conversion into antimonic acid has been complete, and the arsenic as arsenious or arsenic acid. As various oxalates are not absolutely insoluble in water and dilute oxalic acid, traces of them may be found in the solution containing the tin, antimony, and iron, and must be considered in accurate quantitive operations.

In the treatment of the ores, alloys, &c., with aqua regia, it is well, in case antimony is present in large quantity, to mix the solution, before adding the oxalic acid, with chlorine until a distinct and permanent odour of chlorine is perceptible, in order to make sure that all antimony is present as antimonic acid. In presence of zinc it is safest either to evaporate down the solution (after addition of oxalic acid) upon the water bath, or to allow the same oxalic solution, mixed with ammonium chloride or nitrate, to stand for some hours.

In order not to introduce an excess of acid 0·1 grm. of the ore or alloy requires 1 c.c. aqua regia made up of 3 to 4 vols. hydrochloric acid, sp. gr. 1·2, and 1 vol. nitric acid of the same sp. gr., and that this 0·1 grm. requires twice the weight of crystalline oxalic acid $(COOH)_2+aq.$ in order to convert all the dissolved metals into oxalates. If sparingly soluble chlorides or sulphates separate out in the solution, they may be transformed into the corresponding oxalates by boiling with a slight excess of oxalic acid.

If alloys containing tin are treated with nitric acid, the supernatant liquid evaporated to expel nitric acid, the residue or its insoluble portion moistened with a little hydrochloric acid, digested with a strong solution of oxalic acid until the hydrochloric acid is expelled, oxide is dissolved, whilst any metals present forming insoluble oxalates pass into the precipitate. Antimonic acid prepared with strong nitric acid does not possess this property, but the meta-antimonic acid formed by the action of water on antimony perchloride. Solutions of antimonic acid mixed with oxalic acid remain, therefore, clear on dilution with water. It is possible that this different behaviour of tin oxide and antimonic acid may lead to a separation of the two metals.—*Zeitschrift Analyt. Chemie*, vol. xxvi., p. 9.

Bacillus Phosphorescens.—A luminous bacillus has been studied by Dr. Otto Hermes, at the Berlin Aquarium. If in contact with air it gives out in the dark a peculiar bluish-green light, which reminds the observer of the electric light, and which can be communicated to dead fishes and to sea-water. At temperatures exceeding 40° the bacillus loses its luminous property. If the phosphorescence has been transferred to sea-water it disappears in twenty-four hours. Fresh water cannot be rendered luminous by the bacillus.

ON THE ESTIMATION OF SULPHUR IN SOLUBLE SLAGS.

By E. D. CAMPBELL.

The following process may be of enough interest to some of your readers—especially iron and steel chemists—to be worth publishing. I have found the process very rapid and accurate in my work as chemist for this Company.

The estimation of sulphur in soluble slags, or slags decomposed by hydrochloric acid: 0·5 grm. of the finely-pulverised slag is introduced into a cold solution made by taking 25 c.c. hydrochloric acid, sp. gr. 1·19, adding 50 c.c. water and 5 c.c. bromine. A little free bromine is left on the bottom of the beaker. The solution is allowed to stand cold for a few minutes and then gradually raised to a boil, and the boiling continued until the bromine is entirely driven off. The solution is then filtered, a solution of barium chloride added, the whole nearly neutralised with ammonium hydrate, and boiled until the barium sulphate has settled to the bottom. The barium sulphate is then filtered off, washed, ignited, and weighed as usual.

Ohio Iron Company, Zanesville, Ohio,
February 3, 1887.

ON THE EXTRACTION OF VANADIUM AND CHROMIUM FROM IRON ORES, PARTICULARLY FROM MAGNETITE.

By EDO CLAASSEN.

In all treatises on the extraction of vanadium from iron ores which have come into my hands, it is recommended to use the ore for the melting process with sulphur and soda, or with saltpetre and soda, in a very finely pulverised and bolted state; in a few places a repetition of the melting is spoken of as a sure means of getting out all the vanadium present in the ore. The result may be satisfactory if iron ores, such as limonite, which are easily converted into impalpable powders, are used. In cases, however, where ores of considerable hardness, like magnetite, are to be extracted and analysed, the pulverisation alone will not, as many experiments made by me have proved, bring the substance to be operated upon into such a form and condition that, after melting, even if the work is repeated several times, the whole of the vanadium present can with certainty be expected to be transformed into a combination soluble in water.

The chief object, therefore, of my experiments described below was to find out in cases where hard ores, for instance magnetite, are to be dealt with, a short and simple way to bring these into the condition of the finest powders. Mechanical power proved to be insufficient for this purpose, as samples of magnetite brought into a very fine powder were, after ignition with soda and saltpetre, as also with soda and sulphur, and extraction with hot water, still partly magnetic, and, as was shown by special tests, they still contained some vanadium. The following method was finally resorted to, and it gave the desired result in a perfectly satisfactory way:—A quantity of very finely pulverised magnetite was mixed in a capacious dish with an equal weight of water, and then with double its weight of sulphuric acid of 1·840 sp. gr.; the contents of the dish became quite hot, and hence it was thought advisable to cover the vessel, so that any loss of substance might be avoided. When the reaction had ceased, the mixture in the dish was found to be in a nearly dry state. It was now transferred into a platinum crucible and heated, at first slowly, and then after a time with a considerable increase of heat, until the water, then the sulphuric anhydride, and at last the sulphur dioxide formed, were entirely gone. The residue in the crucible, now

probably being the oxidised ore, formed an impalpable powder of a red colour, and of the greatest fineness. As will be shown below, it was in exactly the state of division wanted. I separated it into two parts and treated them as follows :—

I. *Treatment with Soda and Sulphur, &c.*—One portion of the powder was mixed with six times its weight of equal parts of soda and sulphur, then brought into a porcelain crucible, which was now well covered and exposed to gradually increasing heat, until most of the free sulphur was volatilised, *i.e.*, until a flame of burning sulphur was no longer visible outside the crucible. When nearly cold the contents of the crucible were thoroughly extracted with hot water, then filtered and the filtrate acidulated with dilute nitric acid, carefully avoiding loss in consequence of the escape of gas, and then set aside for some time. The liquid was now separated by means of a filter, the precipitate on it washed several times with water, and then brought to perfect dryness. By treating the dry precipitate with carbon disulphide, the free sulphur was easily removed, leaving the vanadium sulphide as a chocolate-brown powder. This, together with the filter, was incinerated in a porcelain crucible, the residue from the evaporated filtrate obtained above, in which there is always a small amount of vanadium present, added to it, and also a small quantity of soda, and the whole ignited. The melted mass, poured on a fragment of porcelain, showed, after cooling, a dark bluish-green colour, *caused by some sodium manganate present.* It was extracted with hot water, the filtered liquid, contained in a flask, mixed with a good deal of ammonium nitrate and boiled, until the smell of ammonia had nearly disappeared. If, after another addition of a little ammonium nitrate, a smell of ammonia is again produced, some more should be added, and the boiling, as well as the addition of a new portion of this salt, should be continued until no smell is evolved after again operating in the same way. Not a trace of the vanadic acid is reduced in this way, which is often the case when neutralising is effected by dilute nitric acid, thus causing the escape of a certain amount of vanadium. However, instead of adding ammonium nitrate, it may be allowed, in cases where a small loss of vanadium is not objected to, to make use of the old method just mentioned of neutralising the alkaline liquid by dilute nitric acid, provided the mixing is done with great care, with constant stirring, always keeping in mind that the reaction of the liquid should never, not even partly or for a moment, turn acid, but always remain at the end a little alkaline.

The liquid, thus treated with ammonium nitrate, was filtered, precipitated with neutral lead acetate (or nitrate), the precipitate washed with water, put together with the filter into a flask, mixed with a sufficient quantity of chlorhydric acid and alcohol, and digested for some time. The precipitate formed by this operation was separated from the green liquid, the filter washed with alcohol, the alcoholic liquids united, evaporated or distilled in a beaker or flask, the remnant mixed with water, treated with hydrogen sulphide, filtered, concentrated by evaporation, poured into a wide porcelain crucible, evaporated on the water-bath, perfectly dried, and ignited. The remaining vanadium pent-oxide, which is mostly impure, and generally contains a little vanadium oxide, gave, repeatedly moistened with a solution of ammonium nitrate and ignited and then extracted for purification with an ammonium carbonate solution or with ammonia, a liquid which, when filtered, evaporated and ignited again in a weighed crucible, left the exact amount of all the vanadium pentoxide present.

The residue on the filter left after the lixiviation of the melted mass obtained by the treatment with soda and sulphur was subjected once more to the same melting process and to all the subsequent operations, for the purpose of showing that all of the vanadium was extracted by *but one* process. The result was a good one, as only a trace of vanadium pentoxide was obtained. The residue left the second time on the filter after melting and lixiviation was then treated as follows :—It was dried, extracted with carbon disulphide, and digested with concentrated chlorhydric acid, which dissolved but a little of it, giving a solution not containing any vanadium or chromium. Most of the residue left here was then by digestion with concentrated nitric acid brought into solution, in which hardly more than a trace of vanadium and no trace of chromium were ascertained. It may be stated here that by the operations just described all the chromium of the ore was left undissolved ; all of it was therefore evidently to be looked for in the small balance of the ore now left after treatment in the above manner. This balance was melted after drying for the extraction of the chromium and also of the vanadium, which had perhaps escaped the solvents, with six times its weight of equal parts of soda and saltpetre, the melted mass lixiviated with hot water and treated as described below under II. While all the chromium of the ore could be stated to be present in the solution, only traces of vanadium could be found in it. I think the above experiments prove clearly that by Treatment I. all the vanadium of the ore finds its way into the solution, while all the chromium is left undissolved. This method of extracting and separating the vanadium is therefore highly to be recommended, particularly if the estimation of this element only is the point aimed at. If, however, it is the object of the analysis to determine the quantity of the chromium as well as that of the vanadium, it may be equally or even more advantageous to make use of the mode of extraction described below under II., which affords nearly as good results, as regards the separation of vanadium, as I.

II. *Treatment with Soda and Saltpetre, &c.*—The other portion of the ore, treated with concentrated sulphuric acid, &c. (see above), was mixed with six times its weight of equal parts of soda and saltpetre, ignited, and perfectly extracted with hot water. The residue was subjected once more to the same operation, and it was only the solution of this last melted mass that was used for the detection and estimation of any vanadium and chromium still left in it. For this purpose it was heated with such an amount of ammonium nitrate that, when the smell of ammonia had disappeared, the addition of a new portion of that salt did not produce it again. The liquid was now precipitated by neutral lead acetate, the precipitate collected on a filter, washed thoroughly, and while still moist digested with chlorhydric acid and alcohol ; the filtrate evaporated to remove, besides the alcohol, most of the acid ; then, after dilution with water, treated with hydrogen sulphide, filtered, evaporated, and ignited. The residue, containing all the vanadium and chromium brought into solution by the last melting process, was mixed, for the purpose of separating these two elements, with soda and sulphur in the proportion of 1 : 3 : 3, and ignited until almost all free sulphur was gone. When cold, the crucible with its contents was put into boiling water ; after filtering, all the chromium present was found on the filter, and all the vanadium in the solution. The filter was incinerated, and the residue mixed with six times its weight of equal parts of soda and saltpetre. After melting, the mass was dissolved in hot water, the solution filtered and precipitated as usual in form of lead chromate.

The vanadiferous filtrate, however, was acidulated in a beaker with diluted nitric acid and filtered after some time ; the residue on the filter, after drying, was extracted with carbon disulphide, mixed with the evaporated filtrate before obtained, and melted. The melted mass, poured on a piece of porcelain, was dissolved in hot water, filtered, boiled for some time, after addition of ammonium chloride, then filtered again and evaporated so far that, after cooling and stirring for a while, no separation of crystals had taken place. Into this solution a lump of ammonium chloride was deposited large enough not to be dissolved entirely ; the precipitate of ammonium meta-vanadate, which separated after a time, was collected on a filter, washed with a sufficient quantity of a saturated

solution of ammonium chloride, dried, and ignited. For the purpose of purification the remaining vanadium pentoxide, after it was moistened with a solution of ammonium nitrate and ignited, was dissolved in ammonia, and the solution evaporated until ammonia could scarcely be detected by the odour, then filtered, evaporated to dryness, and ignited. Very exact analyses demand the collection of the small amount of ammonium metavanadate always remaining in the filtrate, and this is therefore evaporated to dryness and ignited. The residue is digested with some concentrated ammonia, the solution filtered, and precipitated with alcohol. The precipitate, dissolved in a little water, will give a solution, furnishing, when treated as above, with a lump of ammonium chloride, the small residue of ammonium metavanadate. The ignited mass (see above) may also—and this is a good method, after treatment with ammonia, heating to drive off the excess of ammonia, and filtration—be precipitated by lead acetate. The precipitate is then suspended in water, acidulated with nitric acid, and decomposed by means of hydrogen sulphide.* In this way a filtrate is formed which leaves on evaporation and ignition the whole balance of the vanadium pentoxide.

It was already mentioned before that the purpose of melting the ore for the second time with soda and saltpetre was to determine if any vanadium and chromium, and how much, were not extracted the first time. The result of these operations was that scarcely a trace of chromium and but little more than a trace of vanadium were found, so that, if the work is done in a careful way, a repetition of all the operations will surely be unnecessary.

A comparison of the two methods of treatment described shows that Treatment I. is always to be preferred, if it is desired to estimate only the vanadium, because it furnishes at once a solution free from chromium, and the quantity of vanadium left in the ore is smaller, and, further, because a large porcelain crucible can generally be had more easily than a large platinum one.

It is, however, a fact known to every analytical chemist that platinum crucibles are always preferred to such of porcelain, provided there is no objection to use them. With this point in view, it seemed to me to be both interesting and important to ascertain if an addition of a smaller quantity of soda and saltpetre to the treated ore might suffice to decompose it perfectly. The ore or the residue left each time after the ignition and extraction with water on the filter was therefore subjected to these operations three times: the first time it was made strongly alkaline by means of soda and then mixed with the third part of its weight of saltpetre; the second time the residue on the filter was mixed with the third part of each of soda and saltpetre, and the third time double the quantity of an equal weight of each one was mixed with the residue. The result of the melting processes was that the solution obtained the first time was yellow; that of the second time yellowish, and that of the third time hardly yellowish; and while the amount of vanadium and chromium was the largest in the first solution, there was still an appreciable quantity of both in the second; but a little, however, of both in the third. On comparing this result with that above obtained, when the melting was done once only with a considerable quantity of soda and saltpetre, it seems to me clear that, in order to obtain a good result, it is not only advisable, but necessary, to add to the prepared ore about three times its weight of each of these substances.—*American Chemical Journal*, vol. viii., No. 6.

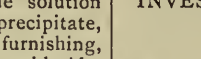
* A precipitate of lead chromate and lead vanadate was suspended in water, acidulated with nitric acid, and treated with sulphuretted hydrogen gas, which decomposed it easily and perfectly. A precipitate, however, of the above lead compounds and of lead sulphate (the last one in considerable excess) did not give an equally good result, although the gas was passed until a strong smell of it remained after standing. It was observed that the smell disappeared again entirely after several hours, although the vessel was well closed, thus showing that a complete decomposition had not taken place. As the same result was obtained after repeated treatment, the precipitate was separated by a filter from the liquid, and both subjected to several tests, which proved that the precipitate contained lead sulphate, lead vanadate, and lead chromate, besides lead sulphide, while in the filtrate sulphuric, vanadic, and chromic acids were found. The above method of decomposing a precipitate of lead vanadate and lead chromate is therefore without doubt a good one only if no lead sulphate, or but a little of it, is present; if, however, a large quantity of it is present, it would be a troublesome and tedious operation to effect the necessary thorough decomposition of the precipitate in this manner. In such a case treatment with chlorhydric acid and alcohol will answer the purpose quickly and satisfactorily.

INVESTIGATIONS ON THE SULPHINIDES.

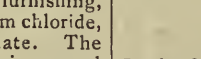
On Benzoic Sulphinide.*

By IRA REMSEN and A. G. PALMER.

In the first paper† of this series it was shown that the salts derived from phthalic sulphinide are formed by the substitution of the imide hydrogen by metallic elements, and it was suggested that in all probability it would be found that the salts of other sulphinides are formed in the same way. This view has been fully confirmed by subsequent investigations in this laboratory; and the results reached by Noyes‡ in investigating nitro-benzoic sulphinide,—

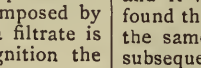


and amido benzoic sulphinide,—



lend additional support to the view.

The sulphinide used in the experiments described below was prepared by oxidation of ortho-toluene sulphamide with potassium permanganate in the usual way. The ortho-toluene-sulphonic acid was prepared by eliminating the nitro-group from nitro-toluene-sulphonic acid by making the diazo-compound and boiling it with alcohol.‖ In regard to benzoic sulphinide a few facts hitherto unknown have been observed. It was found that it can be sublimed without undergoing decomposition, forming thin, elongated, triangular plates. When an aqueous solution of benzoic sulphinide is rendered strongly acid with concentrated hydrochloric acid, and then evaporated almost to dryness on a water-bath, the substance is transformed into ortho-sulpho-benzoic acid, thus:—



In order to prove that the product was really the sulphonic acid it was converted into the sodium salt, which was then treated successively with phosphorus pentachloride and ammonia. Almost the theoretical quantity of the sulphinide was thus obtained. When a solution of the sulphinide is boiled with a concentrated solution of barium hydroxide, ammonia is given off, and the barium salt of ortho sulpho-benzoic acid is formed. From the solution the free acid is easily obtained by precipitating the barium exactly by means of sulphuric acid, and evaporating on the water-bath. From the concen-

* This substance has recently come into some prominence under the name "Saccharin," which is given to it on account of its sweet taste. In the notices of saccharin, even in scientific journals, the statement is constantly made that the substance was discovered by Fahlberg. The statement needs modification. As a matter of fact, the substance came to light in the course of an investigation which Fahlberg undertook at my suggestion, and carried on under my direction, and it was first described in a paper by myself and Fahlberg which appeared in the *Berichte der Deutschen Chemischen Gesellschaft*, Band 12, S. 469. A more detailed account of the investigation was published later in the *American Chemical Journal*, vol. i., p. 426. —I. R.

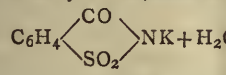
† *American Chemical Journal*, vi., 260.

‡ *Ibid.*, viii., 167.

‖ *Ibid.*, viii., 243.

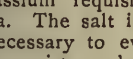
trated solution the free acid separates in white spear-shaped crystals.

Potassium Anhydro-sulphamine Benzoate,



A weighed quantity of benzoic sulphinide was dissolved in water, and to it was added a weighed quantity of pure anhydrous potassium carbonate containing the quantity of potassium requisite to form a salt of the above formula. The salt is extremely soluble in water, and it was necessary to evaporate the solution to almost a syrupy consistency before crystals can be obtained from it. On cooling, short, hard, lustrous, prismatic crystals were deposited. These were filtered off and washed with strong alcohol, dried in the air, and analysed.

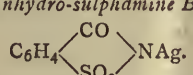
0·2318 grm. air-dried salt lost 0·015 grm. H_2O at 120°. When heated to 200° it lost no more.

	Calculated.	Found.
	—	—
H_2O	7·52	6·90

I. 0·2168 grm. anhydrous salt gave 0·0854 grm. K_2SO_4.
II. 0·2594 ,, ,, 0·1022 ,,

	Calculated.		Found.	
$C_7H_4SO_3N$ ..	182	82·35	—	—
K	39	17·65	17·68	17·68
	221	100·00		

Silver Anhydro-sulphamine Benzoate,



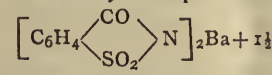
This salt was obtained as a crystalline precipitate by adding a solution of silver nitrate to a warm solution of the sulphinide. It separates almost completely on cooling. It was filtered off, washed with water, and then dissolved in boiling water, in which it is difficultly soluble. On cooling, the salt was deposited in long, white, lustrous needles, which when dry are not changed by light. If a solution of the salt be allowed to stand in the light, it becomes faintly opalescent after a time. The salt contains no water of crystallisation.

I. 0·2817 grm. air-dried salt gave 0·1041 grm. Ag.
II. 0·2685 ,, ,, 0·0998 ,,
III. 0·2258 ,, ,, 0·0840 ,,

	Calculated.		Found.		
			I.	II.	III.
$C_7H_4SO_3N$	182	62·76	—		—
Ag	108	37·24	36·95	37·17	37·20

The silver was determined by heating the salt in the air and afterwards in a current of hydrogen.

Barium Anhydro-sulphamine Benzoate,



The barium salt was prepared by adding pure barium carbonate to a hot solution of the sulphinide. It is easily soluble in water. From the concentrated solution it is deposited in botryoidal masses. Several attempts were made to obtain it in better form, but without success. If a few drops of the solution containing the salt be slowly evaporated on a glass plate, beautiful radiating needles are formed. After separating the salt from the mother-liquor, it was washed with absolute alcohol and dried in the air. The salt loses weight at 180°, but loses nothing above this.

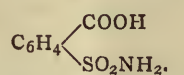
0·2633 grm. air-dried salt lost 0·0265 grm. H_2O at 180°.

	Calculated for $(C_7H_4SNO_3)_2Ba+3H_2O$.	Found.
$3H_2O$	9·69	10·06

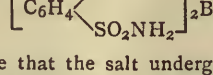
I. 0·2368 grm. anhydrous salt gave 0·1143 grm. $BaSO_4$.
II. 0·2310 ,, ,, 0·1118 ,,

	Calculated.		Found.	
			I.	II.
$(C_7H_4SNO_3)_2$	364	72·65	—	—
Ba..	137	27·35	28·17	28·02
	501	100·00		

The results are not satisfactory, but still they are nearer to those required by the composition assumed than they are to those required by a salt derived from the sulphamine acid—



When this salt was first described* the results obtained pointed to the formula—



It seems probable that the salt undergoes slight decomposition when its solutions are evaporated.

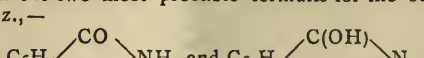
Attempts to Prepare Ethereal Salts of Benzoic Sulphinide.

Although Remsen and Fahlberg state* that phosphorus pentachloride does not act upon benzoic sulphinide, it was thought desirable, in view of the results subsequently obtained by Remsen and Stokes,† to study this reaction somewhat more carefully. Accordingly 4 grms. of the sulphinide and an equal weight of phosphorus pentachloride were thoroughly mixed and gently heated over a free flame. The entire mass became liquid. After cooling, methyl alcohol was poured upon the semi-solid material, but apparently no action took place. On warming, the substance dissolved, Water was added, and the excess of alcohol distilled off. On cooling, about a grm. of benzoic sulphinide was deposited. On further evaporation a deposit of short fine needles was obtained, which, after two crystallisations, were obtained in long, delicate, curved needles, which branched off from one another and arranged themselves concentrically in bunches. They were found to melt at 123° to 125°.

Three grms. of the silver salt of the sulphinide were next placed in a small bottle closed by means of a ground-glass plate which could be clamped tightly down, and an excess of methyl iodide added. This was heated on a water-bath at about 100° for six hours. The formation of silver iodide was noticed soon after the heating began. The contents of the bottle were finally treated with hot alcohol, the silver iodide filtered off, the filtrate diluted with water, and heated to drive off the alcohol. On cooling there separated from this solution delicate, curved, somewhat flattened needles, grouped together concentrically, which resembled the substance above described, obtained by treating the sulphinide with phosphorus pentachloride and methyl alcohol. The new substance melted at first at 116° to 119°, but after two re-crystallisations the fusing-point rose to 128° to 129°. Owing to a lack of time and material the question whether the two substances here referred to are identical or not was for the present left unanswered. The ethereal salts of the sulphinide are now under investigation by Mr. R. N. Brackett, and the results will be published during the next academic year. It is hoped that by a careful investigation of these compounds it will be possible to decide

* *Ibid.*, i. 431.
† *Ibid.*, vi., 260.

between the two most probable formulæ for the sulphinide, viz.,—



—*American Chemical Journal*, Vol. viii., No. 4.

A METHOD FOR THE SEPARATION OF SODIUM AND POTASSIUM FROM LITHIUM BY THE ACTION OF AMYL ALCOHOL ON THE CHLORIDES,

With some Reference to a Similar Separation of the Same from Magnesium and Calcium.*

By F. A. GOOCH.

(Concluded from page 57.)

In this connection it seems best to include the record of certain experiments looking to the separation of the chlorides of sodium and potassium from the chlorides of magnesium and calcium. The behaviour of magnesium chloride towards amyl alcohol is of interest, both with reference to the problem of separating sodium and potassium from lithium and magnesium when the latter are associated, and as concerns the parting of the alkalies from magnesium alone,—a matter which is by no means perfectly simple,— and experiments (38) to (41) touch upon this topic.

The chlorides of sodium and potassium were weighed, as before, in solution; the magnesium chloride was obtained by dissolving in hydrochloric acid the oxide specially prepared and weighed as such. The process of treatment was identical with just that described for the separation of the chlorides of potassium and sodium from lithium chloride.

The residues of the experiments (38) and (39), in which the separation was made by a single precipitation, carried traces of magnesia; those of (40) and (41) in which, two precipitations were introduced, were found to contain in the one case no magnesia, and in the other an unweighable trace. These results point out a method by which the chlorides of sodium and potassium may be obtained free from magnesia, while the small amounts of the former which pass into solution with the magnesium chloride are capable of accurate estimation; and there seems to be no reason why the separation of these alkaline chlorides from magnesium chloride and lithium chloride occurring together should not be effected in one operation, and the parting of the latter salts brought about by the familiar method of precipitating the magnesia in the cold as ammonium-magnesium phosphate.

Experiments (42) to (48), upon the separation of sodium and potassium from calcium by the action of amyl alcohol on the chlorides, yielded the figures of the following table. The mode of treatment was identical with that of the experiments of magnesia, just described, excepting only the substitution of pure calcium oxide, specially prepared, for magnesium oxide.

	Weight of NaCl taken.	Weight of KCl taken.	Weight of NaCl+KCl found.	Corrected weight of NaCl+KCl found.	Volume of amyl alcohol used. Residual. I.	Residual. II.	Total.
	Grm.	Grm.	Grm.	Grm.	C.m.³	C.m.³	C.m.³
(38)	0·1030	0·1064	0·2079	0·2100	23	—	120
(39)	0·0967	0·1024	0·1976	0·2006	33	—	100
(40)	0·1030	0·1073	0·2071	0·2993	13	11	100
(41)	0·1053	0·1093	0·2114	0·2142	12	18	100

	Weight of MgO taken.	Error in Weight of NaCl+KCl found.	Error in corrected Weight of NaCl+KCl found.
(38)	0·1000	0·0015−	0·0006+
(39)	0·1000	0·0015−	0·0015+
(40)	0·1000	0·0032−	0·0010−
(41)	0·1000	0·0032−	0·0004−

From these results it is plain that it is a far more difficult matter to dehydrate and dissolve calcium chloride than either magnesium chloride or lithium chloride. The separation of the chlorides of sodium and potassium from calcium chloride cannot be accomplished, for the quantities employed in these experiments, by a single precipitation; but the repetition of the treatment is effective. In the residues of experiments (46) and (47) calcium could not be found by the test with ammonium oxalate. In a case, therefore, in which the separation of sodium and potassium from lithium, magnesium, and calcium in one operation should be desirable, the end may probably be accomplished by means of the process here described.

Certain preliminary experiments with the nitrates of the bases under discussion indicate that these are susceptible

	Weight of NaCl taken.	Weight of KCl taken.	Weight of NaCl + KCl found.	Corrected weight of NaCl + KCl found.	Volume of amyl alcohol used. Residual. I.	Residual. II.	Total.
	Grm	Grm.	Grm.	Grm.	C.m.³	C.m.³	C.m.³
(42)	0·0859	0·1126	0·2177	0·2195	20	—	100
(43)	0·1018	0·1057	0·2217	0·2235	20	—	100
(44)	0·1096	0·0962	0·2112	0·2130	20	—	100
(45)	0·0985	0·1018	0·2113	0·2130	19	—	100
(46)	0·0914	0·1104	0·1968	0·2000	20	15	100
(47)	0·0997	0·1100	0·2080	0·2019	3	7	90

	Weight of CaO taken. Grm	Error in weight of NaCl + KCl found. Grm.	Error in corrected weight NaCl + KCl found. Grm.
(42)	0·1000	0·0192+	0·0210+
(43)	0·1000	0·0142+	0·0160+
(44)	0·1000	0·0054+	0·0072+
(45)	0·1000	0·0110+	0·0127+
(46)	0·1000	0·0050−	0·0018−
(47)	0·1000	0·0017−	0·0008−

of similar separation by the action of amyl alcohol; and the wide applicability in analytical operations of the general principle involved,—the dehydating of salts by means of amyl alcohol or other liquid of high boiling-point and appropriate solvent action,—can scarcely be a matter of doubt.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Annual General Meeting, February 12, 1887.

Prof. B. Stewart, F.R.S., President, in the Chair.

In opening the proceedings the President regretted that in their Report the Council have to record the loss of one who took a prominent part in the proceedings of the Society,—the late Dr. Guthrie. It was, however, satisfactory to learn that the appeal of the Guthrie Memorial Committee, under the presidency of Prof. Huxley, had been generously responded to.

The Council also learn with regret, from Dr. E. Atkinson, that, owing to pressure of work, he is unable to retain the office of Treasurer to the Society, and desire to express their thanks to him for his past services. Prof. Rücker has consented to be nominated for the office thus rendered vacant, and the Council believe that by his election the connection between the Society and the Normal School of Science (which is so desirable) will be maintained.

The Report of the Council for the year 1886 was read and received, and the following gentlemen were elected Members of the Council for the present year:—

President—Dr. Balfour Stewart, LL.D., F.R.S.

Vice-Presidents—Dr. E. Atkinson; Prof. W. E. Ayrton, F.R.S.; Shelford Bidwell, M.A., LL.B., F.R.S.; Prof. H. McLeod, F.R.S.

Secretaries—Prof. A. W. Reinold, M.A., F.R.S.; Walter Baily, M.A.

Treasurer—Prof. A. W. Rücker, M.A., F.R.S.

Demonstrator—C. V. Boys, M.A.

Other Members of Council—R. H. M. Bosanquet, M.A.; W. H. Coffin; Conrad W. Cooke; Prof. G. Forbes, F.R.S.E.; Prof. F. Fuller, M.A.; Prof. J. Perry, F.R.S.; W. N. Shaw, M.A.; Prof. S. P. Thompson, D.Sc.; C. M. Whipple, B.Sc.; C. R. Alder Wright, D.Sc., F.R.S.

The President proposed the following Resolution:—That at the end of Clause 11 of the Bye-Laws, which says "Every candidate for admission into the Society shall be recommended by not less than three members, to two of which he must be personally known," there be added "When a candidate living abroad is a member of a recognised scientific society, such membership may, subject to the approval of the Council, be held equivalent to the personal knowledge aforesaid." The Resolution was carried, subject to confirmation by a Special General Meeting to be held on February 26th.

A vote of thanks, proposed by Prof. Ayrton and seconded by Prof. McLeod, to the Lords of the Committee of Council on Education, for the use of the rooms and apparatus of the Normal School of Science, was passed unanimously.

The Hon. R. Abercromby proposed a vote of thanks to the officers of the past year for their gratuitous services, which was seconded by Prof. Pickering.

Sir Phillip Magnus proposed a vote of thanks to the auditors, Col. Festing and Prof. Fuller, which was seconded by Mr. Lecky, and passed unanimously.

Mr. J. Brown was elected a member of the Society.

The following communication was then read:—

"*Note on the Tenacity of Spun Glass.*" By E. Gibson and R. E. Gregory.

The authors have experimented on the tenacity of glass rods and fibres made from the same piece of glass. The fibres varied from $\frac{1}{25}$ to $\frac{1}{10}$ m.m., and the rods from about $\frac{1}{2}$ to 1 m.m. in diameter. They find the tenacity per square c.m. of rods increases as the diameter decreases, as in ordinary wires, whereas with fibres this is not shown. Experiments were shown illustrating the methods of working, and the highest tenacity recorded was for a fibre of 0·0340 m.m. diameter, which gave 466×10^7 dynes per square c.m.—a value about half as great as that for steel wires. The authors refer to Quincke's suggestion that the increased tenacity of small wires is due to surface tension, and may be represented by $W = Ad + Bd^2$, where W is the breaking weight and d the diameter; but their own results with glass do not agree with this formula.

Sir Phillip Magnus asked if the diameters were measured at the point of rupture, if the elongation was determined, and whether the authors were able to suggest any other formula which would express their results?

Mr. C. V. Boys remarked that the tenacity being so much affected by accidental circumstances, such as rate of cooling, no such formula could be expected.

Prof. Rücker, referring to Quincke's experiments, said that the surface tension of metals calculated from them appear improbable.

After some further remarks by the President, Prof. Ayrton, Mr. C. V. Boys, Prof. McLeod, and Mr. Gregory, the proceedings terminated.

NOTICES OF BOOKS.

Proceedings of the American Pharmaceutical Association at the 34th Annual Meeting, held at Providence, R.I., September, 1886. Philadelphia: The Association.

The queries proposed for answer at the next annual meeting belong almost exclusively to the region of pure pharmacy. We notice the question—"To what extent can corrosive sublimate be safely used as an antiseptic?"

The Committee on Legislation give abstracts of State enactments on the sale of "poisons," which must in many cases occasion inconvenience in the arts and in scientific research. Thus we regret to see the sale of the mineral acids encumbered with a cloud of formalities.

A section headed "Assays of Commercial *Abstracts*" made us at first inclined to blame the compositor, but as the peculiar term is frequently repeated, we can only presume that it is a neologism for extracts.

The chapter on pepsine calls to our mind a harrowing observation chronicled in "*Cosmos*." A police official in Paris watched a man collecting *album græcum* in the streets, and feeling curious as to its possible uses, traced him to an eminent manufactory of peptones, where he disposed of his gatherings!

In "Butter and its Substitutes" Mr. E. Scheffer proposes as a method for ascertaining the character of butter as genuine or spurious, to ascertain the solubility in a liquid composed of 40 vols. rectified amyle oil and 60 vols. of "Squibb's stronger ether." Genuine butter, it appears, at 82° F. dissolves in 3 c.c. of this liquid, whilst different samples of "butterine" require 11 and 8 c.c. Unfortunately, chemists in Europe do not known what is meant by "Squibb's stronger ether."

Manual of Chemical Manipulation, or of Operative Chemistry. (Manuel de Manipulations Chimiques, ou de Chimie Opératoire.) By Fr. de Walque. Louvain: Aug. Peeters-Ruelens. Paris: Gauthier-Villars. Third Edition. 1887.

The latest edition of this handbook shows a very marked improvement over the previous editions, the most striking and not least valuable alteration being the substitution of

over 350 cuts interspersed throughout the book, for the sheets of illustrations which in the last edition were all collected at the end. In addition to this the whole work has been enlarged and greatly improved: there is, however, a very formidable list of *errata*, which points to a rather hasty correction of proofs.

We are glad to notice that our remarks on the chapter on the production and application of heat have been favourably received. This chapter has been completely remodelled, and due attention given to Fletcher's solid-flame burners and Wiesnegg's furnaces and gas-regulator.

Report of the Jury of Group IV., *Class* 42 (*Chemical and Pharmaceutical Products*), *of the "Exposition Universelle d'Anvers" of* 1885. By Fr. de Walque. Brussels: Alfred Kromont. 1886.

Class 42 in this Exhibition comprised the following materials:—

a. Acids, alkalies, and salts of all kinds.
b. Various products of chemical industries, such as waxes, soaps, perfumes, tars, varnishes, india-rubber, colours, &c.
c. Natural and artificial mineral aërated waters, pharmaceutical products, and patent medicines.

The Report now before us deals in a very comprehensive manner not only with the materials as exhibited, but it also gives descriptions of the various manufactures, pointing out the improvements which have been made, and making suggestions as to what direction further efforts should take. The jury regret, however, that exhibits of pure chemicals were conspicuous by their absence. England we find was poorly represented, although some of the most important houses took part in the exhibition.

The first part of the Report deals with the great chemical industries,—that is to say, the manufacture of soda, which comprises the cycle of operations of sulphur, sulphuric acid, hydrochloric acid, sulphate and carbonate of soda, and chloride of lime. After touching on the Leblanc process we come to that of Messrs. Solvay, and note that this firm exhibited specimens of hydrochloric acid made from common salt during their process, but the jury is of opinion that the cost at present is too high to permit of its being a commercial success. If, however, Messrs. Solvay succeed, as they feel confident they will, it will be the death-blow to the Leblanc process.

In the pages devoted to refined salt we find that the English firms were decidedly in advance of their foreign competitors, both in quality and quantity turned out.

Among the smaller chemical industries we note that Dr. Marquart, of Bonn, had a very excellent collection of crystals of rubidium and cæsium alum.

M. Polier's exhibit of peroxide of hydrogen, made by the reaction of hydrofluoric acid on binoxide of barium, also attracted special attention.

An important subject, which has not yet made much progress, is that of rendering wood and other materials incombustible. Nothing has yet been found better than tungstate of soda for effecting this. The prolonged action of fire on wood, even when protected, eventually effects its decomposition, and the gases escaping catch fire; the carbon, however, which is left behind, does not burn easily when the tungstate has been thoroughly well applied.

Considerable attention has been paid to disinfectants, and the purification of rivers after contamination from chemical works.

The chapter on the manufacture of india-rubber is of great interest; and we next come to pigments and organic colouring-materials, and such like.

Several pages are taken up with a full account of the manner of using the wood Quebracho, containing over 20 per cent of tannin, by a very large German tanner.

The exhibits of natural and artificial aërated mineral waters are next very fully described and comparative tables of analysis given; and finally we have an account of the recent improvements in pharmaceutical products.

The Report as a whole is of great interest, and speaks well for the energy and careful observation of the jury who have issued it.

CORRESPONDENCE.

VAPOUR DENSITY.

To the Editor of the Chemical News.

Sir,—Your correspondent J. W. S., who has difficulty with vapour densities, has perhaps too short or too small a capacity of bulb on his vaporimeter, or is attempting to perform the operation in a draughty place. If the bulb be large enough for the volume of vapour, and no air-draughts about, there should be no tendency to draw back until after the operation is over. The sort of vaporimeter made or procurable in England is not very well adapted for its work. I have found it much better to make them, and to blow a bulb of about 25 c.c. capacity on the side tube leading to the air-collecting tube. This is especially useful with a lead-bath, as then any water drawing back from the trough in which the air-measuring tube is inverted will be held, and prevented from going down into the lead so rapidly; it gives time to take out the cork from the top of the vaporimeter.—I am, &c.,

N. S. S.

February 14, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 1, January 3, 1887.

On a Hydrated Silicon Phosphate.—P. Hautefeuille and J. Margottet.—On submitting to the action of heat a solution of silica in phosphoric acid, there is obtained a compound which crystallises in four distinct forms, and which answers to the formula PO_5SiO_2. If kept for some days at 125° in a platinum crucible this solution deposits spherical concretions. These spherical globules, if immersed in strong sulphuric acid, act powerfully upon polarised light. Their composition is $SiO_2,2PO_5,4HO$.

Action of Sulphur upon Ammonia and upon certain Metallic Bases in Presence of Water.—J. B. Senderens.—Ordinary liquid ammonia, into which pure sulphur had been introduced, was left to itself in a closed vessel at about 12°. After three weeks the liquid began to take a slight yellow tint, which passed gradually into a reddish tone, and became in two years of a very decided red. This liquid contained an ammoniacal polysulphide and a hyposulphite. On exposure to the air sulphur was deposited. The alkaline-earthy bases in solution, if heated in closed vessels with sulphur, behave like alkaline oxides. Oxide of silver and litharge, if heated in sealed tubes with sulphur and water, are converted into silver and silver and lead sulphides and sulphates. Under the same conditions mercury and copper oxides, which are entirely insoluble, produce sulphates and sulphides. Ferric oxide is scarcely acted upon by sulphur, and zinc oxide not at all.

Isomerism of Camphols and Camphors; Camphols of Madder, of Borneol, and of Amber.—Alb. Haller.—All the natural camphols are chemically identical, and differ among themselves only by their action on polarised

light. The camphols of madder, of valerian, of N'gai, of Bang-phien, have the same molecular rotatory power to the left $(\alpha)_D = -37°$. The camphor corresponding to the camphols is identical with the camphor of mother-wort. The camphol of *Dryobalanops camphora* has a rotatory power equal to that of the above camphols, but in the opposite direction. The derivatives are identical with those of ordinary camphor. The camphol of amber seems to consist chiefly of a racemic camphol mixed with a dextro-borneol.

Maximum Vapour-Tensions of Sodium Acetate.—H. Lescœur.—The results of the author's experiments have been given in the form of tables.

Preparation of the Isobutylamines.—H. Malbot.—By heating isobutyl chloride, instead of bromide, with ammonia, dissolved, not in ordinary alcohol but in isobutylic alcohol or in water, the author obtains the three isobutylamines in proportions not greatly differing.

Formation-Heat of Certain Potassium Alcoholates.—M. de Forcrand.—This memoir does not admit of useful abstraction.

Certain Points Relative to the Action of Saliva upon the Grain of Starch.—Em. Bourquelot.—At the temperature where water begins to transform starch into a hydrate saccharifiable by saliva at the ordinary temperature, water mixed with saliva exerts a greater action than do water and saliva used in succession.

No. 2, January 10, 1887.

Action of Carbon Chloride upon Anhydrous Oxides.—Eug. Demarçay.—The author examines if the action of carbon tetrachloride can be utilised for the convenient preparation of the anhydrous chlorides. He has readily succeeded with the oxides of chromium, aluminium, titanium, niobium, tantalum, and zirconium, but not with silica. The reaction must take place at temperatures below redness.

On Erythrite.—Albert Colson.—Erythrite should give successively on oxidation a monobasic and a bibasic acid. The author has obtained the monobasic acid in question—erythritic acid.

On Potassium Glycerinate.—M. de Forcrand.—A thermo-chemical paper, not capable of useful abstraction.

The Derivatives of Erythrene.—MM. Grimaux and Cloez.—Not adapted for abridgment.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 1, January 5, 1887.

New Method for Determining Starch and the Different Kinds of Sugar.—Dr. J. Effront.—The liquid is brought to a degree of concentration such that it may contain from 4 to 9 per cent of sugar, and its rotatory power is observed. Ten c.c. of this liquid are mixed with 10 c.c. of ammonia at 22° B. and 5 c.c. of water. The whole is put in a well stoppered flask, holding 300 c.c., and the stopper is attached to the neck by means of a thread. The flask is set in cold water, which is then heated and let boil for forty minutes. The contents, when cold, are poured into a long-necked flask, in which the liquid is concentrated to 5 to 8 c.c. This concentrated liquid is then cooled and poured into a glass plunged into cold water. After having added 10 c.c. of a solution of sodium hypochlorite (at 7 to 8 per cent of active chlorine), the liquid is agitated, and about 2 c.c. of strong hydrochloric acid are added. The mixture is now poured into a graduated cylinder and made up, by the addition of water, to 25 c.c. The rotatory power of this liquid is then determined, bearing in mind that its volume has been increased in the proportion of 1 : 2½. In his experiments the author has employed Soleil's saccharimeter. If after the treatment with sodium hypochlorite there is formed a persistent froth which makes it impossible to read off accurately the volume of the liquid, this froth may be touched with a glass rod dipped in amylic alcohol, when it will disappear at once.

Researches on Antimony Sulphide.—M. Berthelot.—Already noticed.

Formation of Oxalic Acid in Plants.—MM. Berthelot and André.—Already noticed.

A Relation between the Formation of Oxalic Acid and that of the Albumenoid Principles in Plants.—MM. Berthelot and André.—Already noticed.

On the Speed of Dissociation.—H. Lescœur.—The considerations drawn from the speed of dissociation yield valuable information as to the existence of hydrates and analogous compounds, but they can give neither absolute nor relative indications as to the value of the tensions of dissociation. The speed of dissociation, in fact, is not merely a function of the tension of dissociation, but it depends also on the physical condition of bodies, an element which escapes all measurement.

Caprylidine, an Acetylenic Carbide, its Hydration, and the Constitution of Caprylic Aldehyd.—A. Béhal.—Caprylic aldehyd possesses physical properties similar to those of methyl-hexyl-acetone, but the oxidation of these bodies and their reducing powers being different it is convenient to distinguish them. The substance designated by Limpricht and Bouis as caprylic aldehyd is certainly an aldehyd.

Alloys of Platinum, Iron, and Copper.—E. Maumené.—Copper, at high temperatures, has the power of dissolving iron and platinum. The author has obtained a homogeneous button containing 7·43 per cent of iron, 19·65 of platinum, and 72·92 per cent of copper. This alloy is very liable to oxidation.

Determination of Indigo on Textile Fibres.—A. Renard.—Already noticed.

Action of Oenanthol and Oenanthyle Chloride upon Dimethylaniline, in Presence of Zinc Chloride.—V. Auger.—Oenanthol combines with dimethyl-aniline in presence of zinc chloride. The base obtained is readily decomposed by oxidising agents, with separation of the heptyle group. Oenanthyle chloride combines with dimethyl-aniline, forming either a leuko-base or an acetone, according to circumstances.

Separation of Antimony and Tin.—Ad. Carnot.—Already inserted.

Separation of Antimony, Arsenic, and Tin.—Ad. Carnot.—Already inserted.

Biedermann's Central Blatt für Agrikultur Chemie.
Vol. xv., Part 9.

On Dew.—J. Aitken.—The author rejects the theory of Wills and returns to that of Gersten, propounded in 1733, *i.e.*, that dew is derived from the moist earth.

Formation of Mists.—R. von Helmholtz.—The most usual cause of the formation of mists is the adiabatic expansion of moist air; that is, an expansion which takes place alone at the expense of the internal supply of heat of the gas. Two factors come into play which act in opposition to each other—decrease of pressure and refrigeration. The mist-spherules are not formed out of nothing, but require solid or liquid nuclei, which are always present in the atmosphere. It may be concluded from the existence of clouds that that dust is everywhere suspended in the atmosphere. This confirms Tyndall's conjecture that the blueness of the sky is due to such minute solid particles.

Effects of Chilian Saltpetre.—Prof. Magerstein.—A comparison of the results of this manure, when incorporated with the soil and when used as a top dressing.

Chili Saltpetre, its Importance and Application.—Dr. A. Stutzer.—The author, in a prize dissertation,

shows that results satisfactory to the farmer cannot be attained without nitrogenous manures. The farm-yard manure produced on an estate is generally not sufficient for conveying to the crops the needful quantity of nitrogen. He finds sodium nitrate preferable to ammoniacal salts, and still more decidedly to organic nitrogen.

Comparative Experiments with Chilian Saltpetre and Ammonium Sulphate.— Prof. Magerstein.— These experiments show that sodium nitrate is the more efficient manure except as regards the production of straw.

Iron and the Chlorosis of Plants.—Prof. J. V. Sachs.—The author describes the symptoms of vegetable chlorosis, and recommends the salts of iron as a remedy.

The "Laktokrit."—G. de Laval.—This is an apparatus for testing milk, invented and patented by the author. The principle is the liberation of the fatty matter from its emulsive state by an admixture of acetic and sulphuric acid with the aid of heat, and, secondly, the separation of such fat by centrifugal action.

A Contribution to the Question of the Presence of Nitric and Nitrous Acids in Milk, and the Detec- of the Watering of Milk.—Dr. M. Schrodt.—Milk in its natural state has never been found to contain nitric or nitrous acids. If such are recognised by means of diphenylamine (Soxhlet's process), the presence of well-water may be inferred.

MISCELLANEOUS.

Chemical Labels.—We have just received from Messrs. F. E. Becker and Co. their new book of 330 Chemical Labels, gummed ready for use. The names are very distinctly printed in large type, and the formulæ of the compounds are also given.

Influence of Time on the Transformation of the Colouring-Matters of Coal-Tar in Presence of Wines.—M. Cazeneuve.—The chief coal-tar colours employed for colouring wines, acid magenta, Bordeaux red, purple-red, and rocceline red, may remain in certain wines unchanged for years, and may be recognised on analysis. The chemical modifications which wines undergo, such as the settling in new wines, occasion the precipitation of a larger or smaller part of the artificial colouring. The diseases of wine, such as the action of *Mycoderma vini* and *Mycoderma aceti*, occasion the rapid disappearance of the colour.—*Journ. de Pharm.*

MEETINGS FOR THE WEEK.

Monday, 21st.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Building Materials," by W. Y. Dent, F.C.S.
Tuesday, 22nd.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8. "Wrought Ironwork," by J. Starkie Gardner, F.L.S.
—— Royal Medical and Chirurgical, 8.30.
Wednesday, 23rd.—Society of Arts, 8. "Recent Advances in Sewing Machinery," by John W. Urquhart.
Thursday, 24th.—Royal, 4.30.
—— London Institution, 6.
—— Telegraph Engineers, 8.
—— Royal Institution, 3. "The Critics of the Age of Anne," by Edmund Gosse, M.A.
Friday, 25th.—Royal Institution, 9. "Sunlight Colours," by Capt. W. de W. Abney, F.R.S.
—— Quekett Club, 8. (Anniversary).
—— Society of Arts, 8. "New Markets and Extension of Railways in India and Burmah," by Holt S. Hallett, F.R.G.S.
Saturday 26th.—Royal Institution, 3. "Sound," by the Right Hon. Lord Rayleigh.
—— Physical, 3. "Note on Prof. Carey Foster's Method of Measuring the Mutual Induction of Two Coils," by James Swinburne.

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THE CHEMICAL NEWS.

Vol. LV. No. 1422.

GENESIS OF THE ELEMENTS.*

By WILLIAM CROOKES, F.R.S., V.P.C.S.

In the very words selected to denote the subject I have the honour of bringing before you, I have raised a question which may be regarded as heretical. At the time when our modern conception of chemistry first dawned upon the scientific mind, the average chemist as a matter of course accepted the elements as ultimate facts. He regarded his elements as absolutely simple, incapable of transmutation or decomposition, each a kind of barrier behind which we could not penetrate. If closely pressed he said that they were self-existent from all eternity, or that they had been individually created just as we now find them at the present day. Or he might argue that the origin of the elements did not in the least concern us, and was, indeed, a question lying outside the boundaries of science.

But in these our times of restless inquiry we cannot help asking what are these elements, whence do they come, what is their signification? We cannot but feel that unless some approach to an answer to these questions can be found, our chemistry, after all, is something profoundly unsatisfactory. These elements perplex us in our rearches, baffle us in our speculations, and haunt is in our very dreams. They stretch like an unknown sea before us—mocking, mystifying, and murmuring strange revelations and possibilities.

If I venture to say that our commonly received elements are *not* simple and primordial, that they have *not* arisen by chance or have *not* been created in a desultory and mechanical manner but have been evolved from simpler matters—or perhaps indeed from one sole kind of matter—I do but give formal utterance to an idea which has been, so to speak, for some time "in the air" of science. Chemists, physicists, philosophers of the highest merit declare explicitly their belief that the seventy (or thereabouts) elements of our text-books are not the pillars of Hercules which we must never hope to pass.

Did time allow I might quote utterances of Dalton, of Prof. Faraday, of Dr. Gladstone, of the late Sir Benjamin Brodie, of Prof. Graham, of Dr. Mills, of Prof. Stokes, of Mr. Norman Lockyer, all pointing in the same direction and all showing that in the course of their researches these servants of Science have been led to think that these same elements are not the final outcome—the be-all and the end-all of chemistry.

The law of Prout, and still more the better-established and far-reaching periodic law of Newlands (since developed by Professors Mendeleeff, Meyer, and Carnelley), seem to presuppose the existence of a genetic relation among the elements.

Philosophers in the present as in the past,—men who certainly have not worked in the laboratory,—have reached the same view from another side. Thus Mr. Herbert Spencer records his conviction that "the chemical atoms are produced from the true or physical atoms by processes of evolution under conditions which chemistry has not yet been able to produce."

And the poet has forestalled the philosopher. Milton ("Paradise Lost," Book V.) makes his Archangel Raphael say to Adam, instinct with the evolutionary idea, that the Almighty had created

> "one first matter all
> Indued with various forms, various degrees
> Of substance."

If we can show how the so-called chemical elements might have been generated we shall be able to fill up a formidable gap in our knowledge of the universe. We have a preponderance of cumulative evidence to prove that both heavenly bodies and living organisms have been formed by evolution. We are seeking now to extend this law to the so-called elements, to the first principles of which stars and organisms alike consist.

If we survey the distribution of the chemical elements we find two very distinct cases. On the one hand we see bodies grouped in definite proportions with other bodies from which they differ exceedingly and to which they are held by affinity, more or less strong. To obtain either of two such bodies in a separate state, that affinity, as every student of chemistry knows, must be overcome. Instances of such association are too common and abundant to need mention. In such cases each of the bodies grouped together has fairly marked properties. One of them, moreover, for the most part has an atomic weight very different from that of the other.

In the second case we find bodies associated with other bodies more or less closely allied to themselves. They are not held together by any decided affinity; they are not combined in definite proportions, and their atomic weights are often almost identical. If we wish to obtain one or more of these bodies in a separate state, the difficulty encountered lies not in the strength of the affinities to be overcome but in the circumstance that whatever reagent we employ acts upon one of the substances in nearly the same manner as it does upon the other. Hence, to obtain one body of this kind entirely separate is an exceedingly tedious and difficult task. Nay, we are sometimes at a loss to decide whether we have before us a really simple body or a mixture of bodies whose properties are almost identical.

The most striking instance of such association is found in the metals of the so-called *rare earths*. These bodies form but a very trifling portion of the earth's crust. They are chiefly met grouped together in a few minerals, such as samarskite and gadolinite, which, so far, have been found in but few localities, and even in those are far from common. These earths form a group to themselves; chemically, they are so much alike that it taxes the utmost skill of the chemist to effect even a partial separation, and their history is so obscure that we do not yet know the number of them.

It will not be necessary here to explain in detail the process of chemical fractionation adopted for the separation of the rarer earths, since it could interest only the chemical specialist; moreover, it has been fully described in a paper I read before the British Association at Birmingham.

Stated in the briefest way the operation consists in fixing upon some chemical reaction in which there is the most likelihood of a difference in the behaviour of the elements under treatment, even though the difference be slight, and effecting such treatment incompletely, so that only a certain fraction of the total bases present is separated; the object being to get part of the material in an insoluble and the remainder in a soluble state.

Let us suppose that we have in solution two earths almost identical in their properties, but differing slightly, almost imperceptibly, in basicity. We add to the solution of the earths, which must be very dilute, weak ammonia to such an amount only that it precipitates one-half of the bases present. The dilution must be so great that a considerable time must elapse before the liquid shows a turbidity, and several hours will have to pass over before the action of the ammonia is complete. The liquid is then filtered, by which process we have the earths divided into two parts, no longer identical in their composition. We can easily see that there is now a slight difference in the basic value of the two portions of earths; the portion in solution being, though by a scarcely perceptible amount, more basic than that which the ammonia has precipitated. This minute difference is made

* A Lecture delivered at the Royal Institution, on Friday Evening, February 18th, 1887.

to accumulate systematically until it becomes perceptible either by chemical or physical tests.

The accompanying diagram (Fig. 1) illustrates the scheme of fractionation. Starting from zero at the apex the precipitates all pass to the left and the filtrates to the right. Each circle represents a flask containing the solution under treatment, and the two arrows from each circle show the path pursued respectively by the precipitate and filtrate.

Such is the general outline of the process. But, as has been already intimated, the methods of separation suitable for different groups of earths vary. Where the constituents of yttrium and samarium are concerned, nothing seems available but straightforward fractionation continued month after month and year after year.

The further question whether an earth we have separated is really simple or is still a mixture has again to be decided by yet another process, to be effected only in a vey high vacuum. To understand this process it is necessary to make an apparent total digression.

It seems, perhaps, strange to speak of exhausting the air in hollow bulbs and tubes until there is left in them only the one-millionth part of an atmosphere. It is only in modern times that atmospheric air has come to be regarded as matter. To this day a bottle or a jar is said to be "empty" if it contains no liquid or solid body, the air with which it is filled being completely ignored. According to the same common idea, how empty then must a vessel be when the air it contains is reduced to the one-millionth part of its original quantity! That something still remains is, however, proved by the fact that I have succeeded in reducing the pressure down to one fifty-millionth of an atmosphere. What this number represents will be better understood if I say that, given a barometric column one hundred miles in height, the remaining pressure would be equal only to about the tenth of an inch. Even this high degree of exhaustion by no means represents an absolute vacuum. I have in this glass tube perhaps the nearest approach to perfect emptiness yet artificially obtained. Its internal capacity is 5 cubic centimetres, and it is exhausted to the one fifty-millionth part of an atmosphere. It still contains 100,000000,000000 molecules. The internal space, therefore, is far, very far, from being absolutely void of matter.

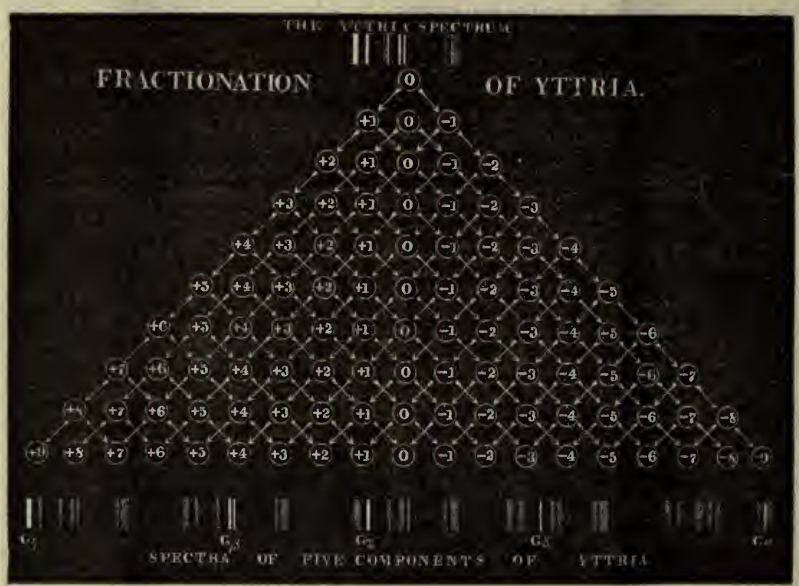
The vacuum most suitable for experiments on these earths is one of about the millionth of an atmosphere. In a vacuum of this degree we find under the action of the induction-spark certain substances phosphorescing or behaving very differently from what they would if similarly treated at a lower vacuum or at the ordinary pressure of the atmosphere. When thus treated, the examination of the spectra of the phosphorescing earths furnishes what I have ventured to call the radiant-matter test.

After a time, on examining the series of yttrium earths in the lowest line of flasks, their phosphorescent spectra are found to have become modified in the relative intensities of some of their lines. Ultimately different portions of the fractionated yttria give the five spectra approximately shown at the foot of the diagram; whilst samaria also appears capable of being split up into two or perhaps three constituents.

These bodies, it must be clearly understood, are not impurities which may be removed, yttrium or samarium remaining in a pure state after their elimination. On the contrary, the molecule we formerly knew as yttrium has undergone a veritable splitting up into its constituents.

These constituents I have not as yet formally baptized. For more convenient reference and discussion I have provisionally ticketed them, as shown in the accompanying Table. (See Table I., next page).

Fig. 1.



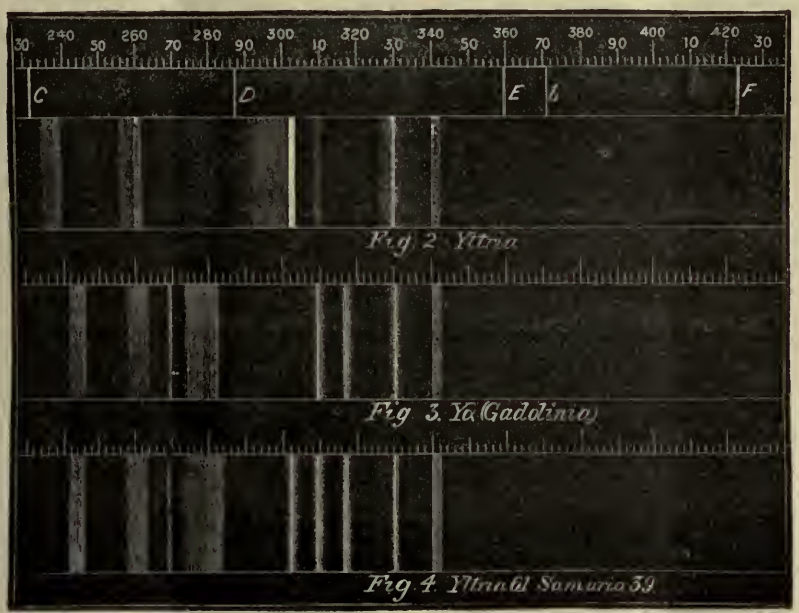
I will rapidly sketch the most salient features of the rare earths when submitted to the radiant-matter test. Some remain unaffected and thus are referred at once to a distinct group. Others have the curious property of preventing the induction-spark passing, and so simulating a non-conducting vacuum, when there is really plenty of residual gas present. The rare earth thoria possesses in the highest degree this obstructive property. Before me I have an exhausted tube having two sets of poles sealed in it, one set at each end. The size and distance apart of these poles are exactly the same in each case. At one end of the tube I have put some thorium sulphate, at the other end I have put yttrium sulphate. The exhaustion is now proceeding by aid of the Sprengel pump. I attach the wires of the induction coil to the poles at the thorium end, and, as you see, no current will pass: rather than pass through the tube, the spark prefers to strike across the spark-gauge in air,—a striking distance of 37 millimetres,—showing an electromotive force of 34,040 volts.

Table I.

Position of lines in the spectrum.	Scale of spectroscope.	Mean wave-length of line or band.	$\frac{1}{\lambda^2}$	Provisional name.	Probability.
Bright lines in—					
Violet	8·515	456	4809	Sγ	New, or ytterbium.
Deep blue..	8·931	482	4304	Gα	New.
Greenish blue (mean of a close pair)	9·650	545	3367	Gβ	New, or the Zβ of M. de Boisbaudran.
Green	9·812	564	3144	Gγ	New.
Citron	9·890	574	3035	Gδ	New, or the Zα of M. de Boisbaudran.
Yellow	10·050	597	2806	Gε	New.
Orange	10·129	609	2693	Sδ	New.
Red	10·185	619	2611	Gζ	New.
Deep red	10·338	647	2389	Gη	New.

Now, without doing anything to affect the degree of exhaustion, I transfer the wires of the induction coil from the thorium to the yttrium end, and the spark passes at once. To balance the spark in air I must push the wires of the gauge together, till they are only 7 millimetres apart, equivalent to an electromotive orce of 6440 volts; the fact of whether thoria or yttria is under the poles making a difference of 27,600 volts in the conductivity of the tube. The explanation of this eccentric action of thoria is not yet quite clear. From the great difference in the phosphorescence of the two earths, it is evident that the passage of electricity through these tubes is not so much dependent on the degree of exhaustion as upon the phosphorogenic property of the body opposite the poles.

Other earths become very phosphorescent, and their power of retaining residual phosphorescence differs greatly among themselves. This property we shall presently see is one of some importance. To examine this persistence of luminosity I have devised an instrument similar to Becquerel's phosphoroscope, but acting electrically instead of by means of direct light. It consists of an opaque disk, 30 inches in diameter, pierced with six openings near the edge. By means of a multiplying wheel and pulley the disk can be set in rapid rotation. At each revolution a stationary object behind one of the apertures is alternately exposed and hidden six times. A commutator forms part of the axis of the disk, and by connecting it with the wires from a battery, rotation of the disc produces alternate makes and breaks in the current. This primary current is then connected with the induction coil, from which the secondary current passes through the vacuum tube containing the earth under examination. When a phosphorescent body such as yttria is examined, if the wheel is turned slowly no light is seen when looked at from the front, as the current does not begin till the obscuration of the tube by an intercepting segment, and ends before the earth comes into view. When, however, the wheel is quickly turned, the residual phosphorescence lasts long enough to bridge over the brief interval between the cessation of the spark and the entry of the phosphorescent body into the field of view, and it is seen to glow with a faint light which becomes brighter as the speed of the wheel increases.



I will first put the phosphorescent earth glucina in the phosphoroscope. This phosphoresces of a bright blue colour, but the residual glow is so short that, with the highest speed of which the instrument is capable, you see no light whatever. In contrast I now put in a compound of the earth strontia. This also glows with a rich blue colour, showing in the spectroscope a continuous spectrum with a great concentration of light in the blue and violet. In the phosphoroscope the colour of the glow is bright green, showing in the spectroscope a continuous spectrum, with the red and blue ends cut off.

Alumina in the radiant matter tube glows with a rich crimson light. I will put some rubies—a crystalline form of alumina—in the phosphoroscope. Here the persistence of luminosity is so great that the red light is visible with the slowest speed, and with a high velocity the residual glow is nearly as strong as when the rubies are out of the instrument.. Shakspere, who is supposed to have

mastered all knowledge, had he seen these rubies could hardly have described them more precisely than in the lines from "Julius Cæsar":—

" . . . with unnumber'd sparks
They are all fire, and every one doth shine."

Another distinctive phenomenon is that the earths of one group, yttrium and samarium, when submitted to the induction discharge *in vacuo*, yield discontinuous spectra.

These spectra are extremely complicated and change in their details in a puzzling manner. For many years I have persistently groped on in almost hopeless endeavour to get a clue to the meaning which I felt convinced was locked up in these systems of bands and lines. It was impossible to divest myself of the conviction that I was looking at a series of autograph inscriptions from the molecular world, evidently of intense interest, but written in a strange and baffling tongue. For a long time all attempts to decipher these mysterious signs were fruitless.

The meaning of the strongly-marked symbolic lines had first to be ascertained. After continued effort I had to be content with roughly translating one group of coloured symbols as "yttrium" and another group as "samarium," disregarding the fainter lines, shadows, and wings frequently common to both. Constant practice in the decipherment has now given me fuller insight into what I may call the grammar of these hieroglyphic inscriptions. Every line and shadow of a line, each faint wing attached to a strong band, and every variation in intensity of the shadows and wings among themselves, has now a definite meaning, which can be translated into the common symbolism of chemistry.

This leads us to what I may call the history of yttrium. Twelve months ago the name yttrium conveyed to all chemists a perfectly definite meaning. It was supposed to be an elementary or simple body, having a fixed atomic weight, 88·9, and its principal properties had been duly determined. Its phosphorescent spectrum gave a definite system of coloured bands, such as you see in the drawing before you (Fig. 2). Broadly speaking, there is a deep red band, a red band, a very luminous citron-coloured band, a pair of greenish-blue bands, and a blue band. These bands, it is true, varied slightly in relative intensities and in sharpness with almost every sample of yttria I examined; yet the general character of the spectrum remained unchanged, and I habitually looked upon this spectrum as characteristic of yttrium; all the bands being visible when the earth was present in quantity, whilst only the strongest of all—the citron band—was visible when traces, such as millionths, were present. But that the whole system of bands spelled yttrium, and nothing but yttrium, I was firmly convinced.

The differences in the spectra of yttrium prepared from different sources are most distinctly seen on comparing the spectrum of yttrium from samarskite with that from gadolinite, hielmite, monazite, xenotime, fluocerite, euxenite, cerite, arrhenite, &c. Still, in spite of these slight differences, the several yttriums are practically all the same thing, and, as I have said, every living chemist a year ago would have regarded them as identical. But they have since yielded to persistent chemical fractionation, and I now call them old yttrium.

One property, above all others, is relied on by chemists as an indisputable proof of the identity of any particular chemical element. When the vapour of an element is rendered incandescent by the electric spark, the characteristic system of lines in its spectrum is regarded as unalterable, and is looked upon as a certain proof that this special element is under examination. However much chemical or other tests fail to show the presence of a given element, the indications of its lines in the spectroscope are regarded as infallible. Spectrum analysis is the court of final appeal, whose decision no chemist has yet had the hardihood to dispute.

By way of illustration I will project on the screen the very characteristic system of lines given by yttrium when ignited by the electric spark,—a system, be it remembered, having no connection whatever, with the peculiar phosphorescent spectrum yielded by yttrium. The coloured diagram gives as accurate a representation of the spark spectrum of yttrium as can be drawn by hand. Omitting minor lines you will notice two very strong groups of lines in the red and orange. These lines have been always regarded as the characteristic test for yttrium; the presence of these groups proves the presence of yttrium, and their absence proves its absence.

I now project the electric spark spectrum of Gδ, as pure as I have been able to prepare it. Gδ is one of the bodies which by long and tedious fractionation I have separated from yttrium; it occurs at one extreme end of the fractioning, and differs not only from the parent yttrium in its phosphorescent spectrum, but by virtue of the process adopted for its isolation it must likewise differ in chemical properties. But what tale does the spectrum tell? It tells us there is absolutely no difference between this spectrum and that given by old yttrium.

I now pass to the other end of the fractionation of yttrium, where a body, Gη, concentrates giving a totally different phosphorescent spectrum to that given by Gδ. And it also differs chemically from old yttrium, and in a more marked manner from its brother, Gδ, at the other extremity of the fractionation. Look at its spark spectrum! It is perfectly identical both with old yttrium and with Gδ, and when I examine these three spectra in my laboratory with all the appliances for exact measurement, the whole system of lines is still identical.

What inference can be drawn from these results? Is discredit to be thrown on spectrum analysis? Is the superstructure which has been so laboriously raised upon its indications to fall to the ground? By no means. Spectrum analysis and its grand generalisations are on as firm a foundation as ever. I see two possible explanations of the facts I have brought before you. According to one hypothesis research has somewhat enlarged the field lying between the indications given by ordinary coarse chemistry and the searching scrutiny of the prism. Our notions of a chemical element have expanded. Hitherto the molecule has been regarded as an aggregate of two or more atoms, and no account has been taken of the architectural design on which these atoms have been joined. We may consider that the structure of a chemical element is more complicated than has hitherto been supposed. Between the molecules we are accustomed to deal with in chemical reactions and ultimate atoms as first created, come smaller molecules or aggregates of physical atoms; these sub-molecules differ one from the other, according to the position they occupied in the yttrium edifice.

Perhaps this hypothesis can be simplified if we imagine yttrium to be represented by a five-shilling piece. By chemical fractionation I have divided it into five separate shillings, and find that these shillings are not counterparts, but like the carbon atoms in the benzol ring, have the impress of their position, 1, 2, 3, 4, 5, stamped on them. These are the analogues of my Gα, Gβ, &c. If I now bring in a much more powerful and searching agent,—if I throw my shillings into the melting-pot or dissolve them chemically,—the mint stamp disappears and they all turn out to be silver. I submit my yttrium, or my Gα, Gβ, &c., to the intense heat of the electric spark, the little differences of molecular arrangement vanish, and the atoms, of which the molecules of yttrium, Gα and Gβ are alike composed reveal their presence in identical spectra.

An alternative theory commends itself to chemists, to the effect that the nine bodies shown in the above table (Table I), are new chemical elements differing from yttrium and samarium in basic powers and several other chemical and physical properties, but not sufficiently to enable us to effect any but a slight separation. One of these bodies, Gδ, gives the phosphorescent citron line, and also the brilliant electric spectrum I have just exhibited. The other eight do not give electric spectra

which can be recognised in the presence of a small quantity of Gδ, whilst the electric spectrum of Gδ is so sensitive that it shines out in undiminished brilliancy even when the quantity present is extremely minute. In the process of fractionation, Gα, Gβ Gδ, &c., are spread out and more or less separated from one another, yet the separation is imperfect at the best, and at any part there is enough Gδ to reveal its presence by the sensitive electric spark test. The arguments in favour of each theory are strong and pretty evenly balanced. The compound molecule explanation is a good working hypothesis, which I think may account for the facts, while it does not postulate the rather heroic alternative of calling into existence eight or nine new elements to explain the phenomena. However, I submit it only as an hypothesis. If further research shows the new element theory is more reasonable, I shall be the first person to accept it.*

I now will introduce to you a substance which has been to me what the celebrated Rosetta stone was to the interpreters of Egyptian inscriptions. I received it from M. de Marignac, and it was nothing more than a small specimen of a new earth which he had obtained and had named provisionally Yα.

In the radiant-matter tube this earth gives a bright spectrum as in the diagram before you (Fig. 3).

If we compare this spectrum with that ascribed to "old yttrium" (Fig. 2) we see that, omitting minor details, Yα is yttrium with the characteristic citron band left out and the green and orange bands of samarium added. Now look at the following diagram (Fig. 4), which represents the spectrum of a mixture of 61 parts of yttrium and 39 parts of samarium. It is almost to its minutest details identical with the spectrum of Yα, but the citron band is as prominent as any other band. Hence Yα is shown to consist of samarium, with the greenish blue of yttrium and some of the other yttrium bands added to it. It proves, further, that the citron band which I had hitherto regarded as one of the essential bands of the yttrium spectrum can be entirely removed, whilst another characteristic yttrium group, the double green band, can remain with heightened brilliancy.

If now it were possible to remove the citron band-forming body from this mixture, I should leave Yα behind; I should, in fact, have recomposed Yα from its elements. I have no doubt whatever that this will ultimately be accomplished, but the preliminary work of fractionation is tedious to the last degree, and for its completion would occupy a space of time in comparison with which the life of man is all too brief.

Whilst I have not yet chemically removed the citron forming constituent, I can physically suppress the citron band and show an artificial spectrum, imitating in the closest degree the natural spectrum of Yα.

By means of the electrical phosphoroscope I am enabled to catch the spectrum of an earth immediately after it has suffered molecular bombardment in the vacuum. In this way I get the spectrum of the residual phosphorescence, and I have found that not all the constituents of these earths emit residual phosphorescence for the same duration of time.

When a little strontium is added to the yttrium-samarium mixture, the effect in the phosphoroscope is to suppress the residual phosphorescence of Gδ—the citron band—and to enhance the phosphorescence of Gβ, the double green band, and the imitation of the Yα spectrum is complete.

I must here call attention to the experiments of Prof. A. E. Nordenskiöld, in the *Comptes Rendus* of the French Academy of Sciences for November 2nd, 1886. This eminent savant is working in the same direction as myself, with results which decidedly corroborate my experiments. He has taken the crude mixture of yttria, erbia, ytterbia, &c., just as it is precipitated from the minerals containing these rare earths. This mixture, for brevity's sake, he calls gadolinia, and he finds that this gadolinia, though palpably a compound body, has always a constant atomic weight, whatever the mineral from which it has been extracted. Or, to use Prof. Nordenskiöld's own words, "*Oxide of gadolinium, though it is not the oxide of a simple body, but a mixture of three isomorphous oxides* (even when it is derived from totally different minerals found in localities far apart from each other) *possesses a constant atomic weight.*" Therefore, as he significantly observes, "*We are in presence of a fact altogether new in chemistry.* For the first time we are confronted with the fact that three isomorphous substances, of a kind that chemists are still compelled to regard as elements, occur in nature not only always together, but in the same proportions. It seems that chemists here find themselves face to face with a problem analogous to that presented to astronomers in the origin of the minor planets."

These facts throw a new light upon certain important chemical questions. For the old yttrium passed muster as an element. It had a definite atomic weight, it entered into combination with other elements, and could be again separated from them as a whole. But now we find that excessive and systematic fractionation has acted the part of a chemical "sorting Demon," distributing the atoms of yttrium into groups, with certainly different phosphorescent spectra, and presumably different atomic weights, though, from the usual chemical point of view, all these groups behave alike. Here, then, is a so-called element whose spectrum does not emanate equally from all its atoms; but some atoms furnish some, other atoms others, of the lines and bands of the compound spectrum of the element. Hence the atoms of this element differ probably in weight, and certainly in the internal motions they undergo.

This is unlikely to be an isolated case. We may assume that the principle is of general application to all the elements. In some, possibly in all elements, the whole spectrum does not emanate from all their atoms, but different spectral rays may come from different atoms, and in the spectrum as we see it all these partial spectra are present together. This may be interpreted to mean that there are definite differences in the internal motions of the several groups of which the atoms of a chemical element consist. For example, we must now be prepared for some such events as that the seven series of bands in the absorption-spectrum of iodine may prove not all to emanate from every molecule, but that some of these molecules emit some of these series, others others, and in the jumble of all these molecules, to which is given the name "iodine vapour," the whole seven series are contributors.

Another important inference to be drawn from the facts is that yttrium atoms, though differing, do not differ continuously, but *per saltum*. We have evidence of this in the fact that the spectroscopic bands characteristic of each group are distinct from those of other groups, and do not pass gradually into them. We must accordingly expect, in the present state of science, that this is probably the case with the other elements. And the atoms of a chemical element being known to differ in one respect may differ in other respects, and presumably do somewhat differ in mass.

Returning, after this digression, to the idea of heavy

* Neither of these theories agrees with that of my distinguished friend, M. Lecoq de Boisbaudran, who also has worked on these earths for some time. He considers that what I have called old yttrium is a true element, characterised by the spark spectrum already exhibited, but not giving a phosphorescent spectrum *in vacuo*. The bodies giving the phosphorescent spectra he considers to be impurities in yttrium. These he says are two in number, and he has provisionally named them Zα and Zβ. By a method of his own, differing from mine, M. de Boisbaudran obtains fluorescent spectra of these bodies; but their fluorescent bands are extremely hazy and faint, rendering identification difficult. Some of them fall near lines in the spectra of my Gβ and Gδ. At first sight it might appear that his and my spectra were due to the same bodies, but, according to M. de Boisbaudran, the chemical properties of the earths producing them are widely distinct. Those giving phosphorescent lines by my method occur at the yttrium extremity of the fractionation, where his fluorescent bands are scarcely shown at all; whilst his fluorescent phenomena are at their maximum quite at the terbium end of the fractionation, where no yttrium can be detected even by the direct spark, and where my phosphorescent lines are almost absent.

and light atoms, we see how well this hypothesis accords with the new facts here brought to light. From every chemical point of view the stable molecular group, yttrium, behaves as an element. To split up yttrium requires not only enormous time and material, but the existence of a test by means of which the constituents of yttrium are capable of recognition. Had we tests as delicate for the constituent molecular groups of calcium, this element also might be resolved into simpler groupings. It is one thing, however, to find out means of separating bodies which we know to be distinct and to have colour or spectrum reactions to guide us at every step; it is quite another thing to separate colourless bodies which are almost identical both in chemical reaction and atomic weight, especially if we have no suspicion that the body we examine is a mixture.

Again it seems as if bodies we have been accustomed to regard as absolutely simple and elementary may be split up in different directions according to the means we bring to bear upon them. Until very lately our text-books made mention of an element under the name of didymium. With some trouble it had been separated from its accompanying bodies lanthanum and cerium. Its properties had been examined, and no one doubted its distinct and elementary character. It was viewed according to one of the common definitions of an element, as "a something to which we can add, but from which we can take nothing." When, behold! Dr. Auer von Welsbach, examining this supposed simple body in a novel manner, succeeded in decomposing it into two simpler bodies, which he called neodymium and praseodymium; and later researches, in which I have had a share, show that even neodymium and praseodymium are not the simplest bodies into which didymium can be dissected.

(To be continued.)

A NEW APPARATUS FOR THE DETERMINATION OF VAPOUR DENSITIES.

By Dr. GIBSON DYSON.

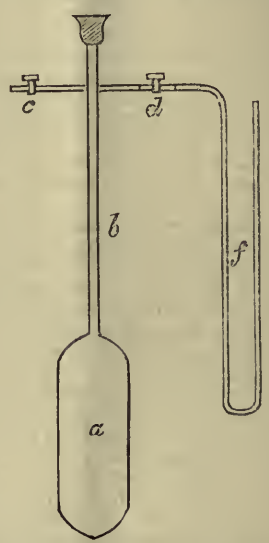
I HAVE for some time past been engaged with the construction of a new apparatus for the determination of vapour densities of such substances as are not volatile without decomposition in contact with air or under ordinary atmospheric pressure. So far I have every reason to believe the process to be trustworthy, and I hope before long to publish a series of determinations bearing out this view. Unfortunately, circumstances compel me to publish the work in this incomplete form.

It is proposed to determine the vapour densities of solid and liquid substances by measuring the increase of pressure caused by the volatilisation of a known weight of the substance in a given space. The apparatus employed is represented in the adjoining figure. *a* is a bulb of about 250 c.c. capacity, and to this is attached a tube (*b*) having an inner diameter of 4—5 millimetres and a length of 5 decimetres. This tube is widened at the top to admit of an arrangement, similar to that used with V. Meyer's apparatus, so that the substance can be introduced without removing the cork. To the tube *b* are fused two capillary side tubes, *c* and *d*, each of which is fitted with a stop-cock. The tube *d* is connected with the manometer, *f*. The capacity of the bulb *a* and tube *b* must now be ascertained, and the apparatus is then ready for use.

The following is the manner in which a determination is conducted:—

The apparatus is first thoroughly dried by passing a current of dry air through it, and then some dry sand or asbestos is placed at the bottom of *a*. The bulb is next immersed in a bath, the temperature of which is known, and the weighed substance (about 0·05—0·1 grm.) is placed ready for dropping into the apparatus (one of the best arrangements for this purpose is that devised by L. Meyer, *B.*, 13, 991). If it is desired to conduct the experiment under reduced pressure, the tube *c* is connected with a mercury pump; as soon as the pressure in the apparatus is sufficiently reduced, the stop-cock at *c* is closed and the pump disconnected.

The heating is now continued until the temperature, and consequently the pressure, is constant, and then the substance is introduced. The pressure in the apparatus quickly rises, and as soon as it has reached its maximum the stop-cock at *d* is closed and that at *c* opened.



The increased pressure is now accurately read off on the manometer, and from this the vapour density of the substance can be calculated. If it is desired to conduct the experiment in an atmosphere of nitrogen, or any other gas, it is only necessary to displace the air in the apparatus by it before proceeding with the determination.

The following data are required:—

V = capacity of $(a)+(b)$.
p = pressure before introduction of substance.
p' = pressure after introduction of substance.
t = temperature of bath.
S = weight of substance taken.

The vapour density is obtained by the following equation:—

$$\frac{S \times 760\,(1 + 0{\cdot}003665\,t)}{V \times (p' - p) \times 0{\cdot}001293} = \text{Vapour density.}$$

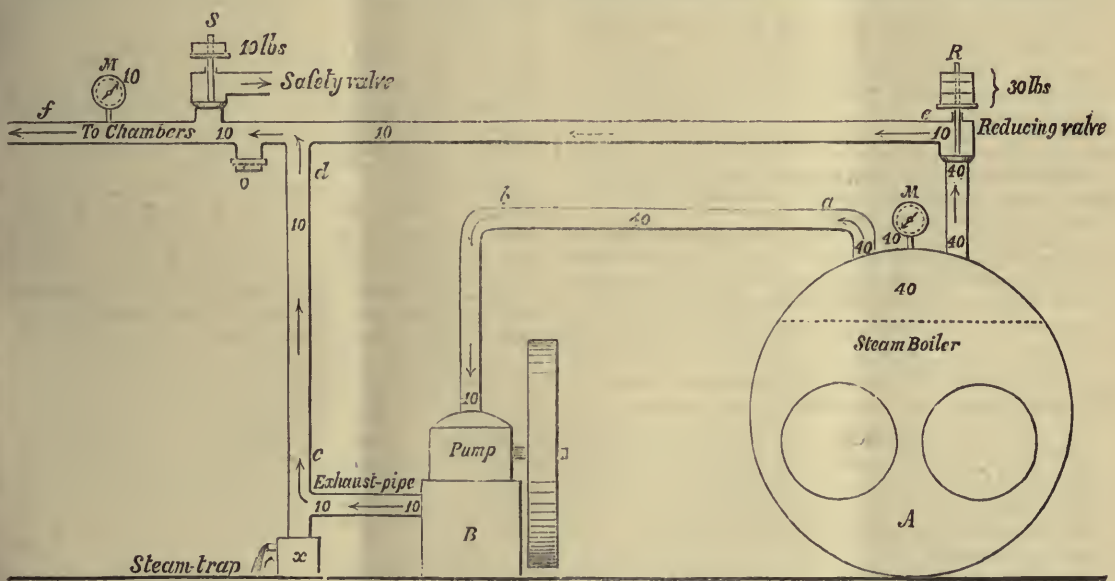
The Brooklyn Academy of Science.—This Academy has been recently formed with the object of affording an opportunity of scientific study and research to those who would otherwise be without. A course of free lectures is also being delivered on such subjects as "The Chemistry of Salt," "The Story of a Plant," &c. The Academy is under the supervision of Prof. G. W. Thompson.

Missouri School of Mines.—It having been found that the space allotted to chemical and metallurgical work at this school was inadequate, it was decided to apply to the Legislature for a new chemical laboratory. A grant having been made, plans were made by Prof. C. E. Wait, under whose supervision it was erected; and the school may now be congratulated on having a very commodious and well appointed laboratory, comprising two large rooms, one for qualitative and one for quantitative work, an assay laboratory, a large lecture theatre, two balance rooms, and two evaporating rooms.

AN IMPROVEMENT IN THE PRODUCTION OF SULPHURIC ACID.

By H. SPRENGEL, Dr. phil., F.R.S.

MECHANICAL operations, such as the pumping of water and the compressing of air, absorb in Sulphuric Acid Works which possess Gay-Lussac- and Glover-towers a not inconsiderable amount of steam, and consequently of fuel. This steam, after having spent its energy in the engines, is (as a rule) allowed to escape into the open air. It is obvious that this escaping steam, the so-called "exhaust-steam," might render a second service by virtue of its chemical properties, if it could be made to substitute *(without much trouble and expense, and without causing irregularities and disorder)* a part of another quantity of steam, which in Sulphuric Acid Works has to be raised almost entirely for the sake of a chemical operation, viz., the formation of acid inside the leaden chambers.



This problem* I have solved in the following manner:†—

Be it remembered that the work done by a steam-engine is the result of the difference of pressure which exists alternately on the two sides of its piston. Supposing this pressure be 30 lbs. per square inch on the one side and *nil* on the other, the work done will be due to the difference of these 30 lbs. per square inch. Hence the same work may be done by the same engine, if the pressure be kept at 40 lbs. per square inch on the one side of its piston and at 10 lbs. per square inch on the other, for the difference of pressure remains unaltered, or 30 lbs. per square inch.

In factories of an average size not more than one steam-boiler serves, as a rule, to supply steam of a uniform pressure of about 30 lbs. per square inch both to the engines and to the chambers. As, however, a pressure of 10 lbs. per square inch is ample and to spare for the steam entering the chambers, I now, in harmony with the above view,—

(1) Raise the pressure in such a steam-boiler by 10 lbs. per square inch, *i.e.*, in this case from 30 lbs. to 40 lbs.,

(2) Drive the engines at this higher pressure,

(3) Make the exhaust-steam from the engines enter the chambers at a pressure of 10 lbs. per square inch and—

(4) Supplement, when needed, any deficiency of steam in the chambers by another quantity of steam of the same pressure, *i.e.*, steam of 10 lbs. per square inch, drawn from this very boiler which is kept at a constant and regular pressure of 40 lbs. per square inch.

How this may be done, in a convenient and inexpensive manner, will be readily understood by referring to the annexed diagrammatic sketch.

A represents a steam-boiler and B a pump, supplied with steam of a constant pressure of 40 lbs. per square inch by the pipe *a b*. The exhaust-steam of this pump escapes through *c d* into the main steam-pipe *e f*, which carries steam of a pressure of 10 lbs. per square inch to the chambers. This main steam-pipe *e f* is connected with the steam-boiler A, and is provided with two valves:—

(1) A reducing-valve, R, and

(2) A safety- or escape-valve, S.

These two valves are weighted in such a manner that, as soon as the pressure in *e f* becomes less than 10 lbs. per square inch, the valve R will admit steam from the boiler until a pressure of 10 lbs. is re-established in *e f*; while as soon as the pressure in *e f* becomes more than 10 lbs. per square inch, the valve S will allow an escape of steam into the open air until a pressure of 10 lbs. is re-established in *e f*. In other words, and by way of an example, a 40 lbs. pressure in the boiler will lift and overcome a 30-lb. weight plus a 9½-lb. counter-pressure of steam at R, while a 10½-lb. pressure in *e f* will lift a 10-lb. weight at S.

Thus it will be seen that one boiler and one system of pipes are sufficient to supply simultaneously both the engines with high-pressure steam and the chambers with low-pressure steam.

To ensure, what is much to be desired, an even, constant, and regular pressure in *e f*, it is essential that these valves R and S should be sensitive, or, in technical language, not be liable to "stick."

M and M¹ represent manometers for indicating the pressure inside the boiler A and the pipe *e f*; while *x* represents a steam-trap and an outlet for condensed steam which in the form of water will collect in the pipes above *x*.

* For an attempt to solve this problem in a different manner by the help of *two* steam-boilers, and in a case where the exhaust steam was derived from *one engine only*, see Dr. G. Lunge's excellent "Treatise on the Manufacture of Sulphuric Acid and Alkali." London: Van Voorst. 1879, vol. i., pp. 393 and 565.

† The author's British patent No. 10,798 of Aug. 24, 1886.

In the same way as the exhaust-steam from only one pump is shown here to be utilised, so the exhaust-steam from two or more pumps may be utilised by connecting the same with *e f*, for instance at *o*.

Though this invention relates in the first instance to the utilisation of exhaust-steam of engines which are to be met with in every Sulphuric Acid Works possessing Gay-Lussac- and Glover-towers, it is obvious that the exhaust-steam from any other engine, which happens to be discharged into the open air in the vicinity of sulphuric acid chambers, may be utilised as before described, even if this exhaust-steam should be derived from an engine supplied with steam from a different boiler at a different pressure, for the regularity of pressure needed in the chamber steam-pipes will thereby not be affected, but will still be maintained by the valves R and S. In fact, the use of exhaust steam in the manufacture of sulphuric acid may be carried with advantage to the point at which the sum total of the thus collected quantity of exhaust-steam equals the total quantity of steam needed in the chambers.

Hence, only after this point has been passed, is there good reason to employ, in the vicinity of sulphuric acid chambers, engines from which there is no escape of exhaust-steam properly speaking, *e.g.*, the so-called condensing-engines.

Finally, I beg to state that I do not restrict myself to the above-stated pressures of 40 and 10 lbs. per square inch as the only ones which may be used. I merely have given these pressures as those at which I have obtained very satisfactory results.

As an experimental proof it may be mentioned that, by utilising in this manner the exhaust-steam from *four* small engines attached to the water-pumps and air-compressers at the Works of my licensees—the *Lawes' Chemical Manure Company*, Creek's Mouth, Barking, Essex—I have been able to dispense with one of two steam-boilers formerly in use, thus reducing the consumption of coal 34 per cent; the quality of coal and the amount of work done remaining unaltered. The savings in coal alone, at a price of 9s. 3d. per ton, repaid, in this instance, the cost of the apparatus after having been in use for three months and eight days, while the profit on the investment amounted to 370 per cent per annum. This apparatus has now been in daily use for one and a half years, delivering the steam, however varying and intermittent at its sources, with unfailing regularity and constancy of pressure at the chambers. It hardly need be said that this *regularity* and *constancy of pressure* is one of the factors on which a good yield of acid depends in no small a measure.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, February 17th, 1887.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

MESSRS. E. Hori and Charles E. Sohn, Jun., were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Harold Govett Colman, Owens College, Manchester; James Tudor Cundall, Dale Side, Hampton Redland, Bristol; Alfred John Evans, B.A., Sheegorah House, Boyle, Ireland; Arthur Harden, Ashville, Upper Charlton Road, Manchester; William Houlding, Stanley House, Anfield, Liverpool; Theophilus Horne Redwood, 154, Ladbroke Grove Road, W.; George Robertson, Madeira Villa, Woodford, Essex; W. Harry Stanger, 23, Queen Anne's Gate; Patrick T. O'Sullivan, 57, Great Britain Street, Cork.

It was announced that the following changes in the Council List were proposed by the Council:—

As President—Mr. W. Crookes, F.R.S., *vice* Dr. Hugo Müller, F.R.S.

As Vice-Presidents—Prof. M'Leod, F.R.S., Prof. Schorlemmer, F.R.S., and Mr. Ludwig Mond, *vice* Mr. Crookes, F.R.S., Prof. Liveing, F.R.S., and Prof. T. E. Thorpe, F.R.S.

As Ordinary Members of the Council—Prof. A. H. Church, Dr. P. F. Frankland, Prof. Kinch, and Dr. H. F. Morley, *vice* Messrs. H. T. Brown, A. E. Fletcher, and Profs. Meldola and Pickering.

Messrs. C. W. Heaton, P. F. Frankland, and Wyndham Dunstan were appointed by the meeting to audit the Treasurer's accounts.

The following papers were read:—

11. "*The Influence of Temperature on the Heat of Dissolution of Salts.*" By S. U. PICKERING.

This is an extension of the author's previous work on the sulphates, entitled "The Influence of Temperature on the Heat of Chemical Combination" (*Trans.*, 1886, 260), which tended to show that the heat of dissolution of a salt does not increase regularly with a rise of temperature, but that irregularities occur at various points, so that the heat of dissolution must be represented by a series of curves. The experiments with potassium sulphate, hydrated and anhydrous magnesium sulphate, and hydrated and anhydrous copper sulphate have been re-repeated, and the investigation extended to potassium, sodium, hydrated and anhydrous strontium chloride, potassium and the two strontium nitrates, the two sodium carbonates, sodium acetate, and potassium sodium tartrates. The investigation comprises over 700 determinations, the mean results with each salt being deduced from two to five distinct series of experiments, each performed with different thermometers. The observations extended from 3° to 25°. In all cases it was found that the irregularities previously noticed were the result of error, and that the heat of dissolution of a salt is represented by a series of straight lines. In rising from low temperatures the heat of dissolution is expressed by a straight line up to a certain point, when the rate becomes suddenly lowered, and remains constant till a further sudden reduction occurs at some still higher temperature. The average divergence of all the mean results from lines of perfect straightness amounted to less than one-thousandth of a degree.

With the normally anhydrous salts one lowering of the rate (amounting to about 30 per cent) only was observed between 3° and 25°, occurring at temperatures between 14° and 9·5° in the various cases; while with the salts which combined with water of crystallisation the first alteration occurred at temperatures between 9° and 7°, and a second change took place at 21° to 18°; the frequency as well as the temperature of occurrence appearing to depend mainly on the tendency of the salt to combine with water. This lowering of the rate of increase in the heat of dissolution as the temperature rises must be accompanied by an increase in the specific heat of the solution which would indicate decomposition of some description.

Marignac's determinations of the specific heat of solutions give a rate of increase agreeing very closely with the author's results, and they also show that a further lowering takes place at temperatures above 25° up to 50°. Tilden's direct determinations of this rate at the higher temperatures show a very much larger decrease in the rate, but they cannot be freely accepted, as they are entirely at variance not only with all specific heat determinations, but also with a fundamental principle of thermo-chemistry.

The heat of combination of a salt with its water of crystallisation is deduced from the author's results. He concludes that it is not a constant quantity at all temperatures, the general effect of rise of temperature being to

diminish it, although at very low temperatures this effect seems to be more than counterbalanced by some other cause, probably the tendency of the water molecules to unite with each other, the heat of combination diminishing then with fall of temperature. The more water a salt contains the more marked are both these results.

Discussion.

Dr. Alder Wright thought that the Society was to be congratulated on the fact that one of its members had undertaken the laborious and delicate work involved in making accurate thermo-chemical determinations of heats of dissolution, and in avoiding the numerous sources of error which attend such valuations. He found it somewhat difficult to realise the practicability of obtaining exactitude of such an order that the experimental errors should not exceed two or three calories, which apparently Prof. Pickering claimed to have done. Julius Thomsen, in his most accurate and painstaking researches, generally found a minimum variation from the mean in consecutive observations of from ± 5 to ± 10 calories; and Dr. Alder Wright himself, whilst working on the heat of dilution of concentrated solutions (with, however, less complete appliances than those used by Thomsen), found that about ± 10 calories was the minimum experimental error attaching to each separate valuation. The question of the amount of the experimental error seriously affected Prof. Pickering's conclusion, that the curves indicating his results frequently consisted of two or more straight lines, making an angle or sudden break in the curve; it would seem far more probable, *à priori*, and in view of the general course of physical phenomena, in which some value is a function of the temperature, that the curve is truly *a curve* throughout, expressible by some such symbols as $1+\alpha t+\beta t^2$, where β may be + or −. Judging from some of Prof. Pickering's diagrams, the deviations exhibited by some of his observations from the sets of straight lines deduced by him as mean results, are as great as, if not greater than, the deviations which they would exhibit from a mean curve of this kind; and until it had been shown that the deviations in this latter case were materially wider than could be accounted for by the degree of magnitude of the experimental errors, whilst in the former case this was not so (which so far Prof. Pickering had not done), he should feel some degree of difficulty in accepting the conclusion that the curves are not regular ones, but are portions of the bounding circumferences of irregular polygons.

[Prof. Tilden writes, with reference to the statement made by Mr. Pickering, that he had used too little water in his experiments on the heat of dissolution of potassium sulphate, and that the salt could not have been all dissolved, that in every experiment of which the results were quoted in his paper the salt was entirely dissolved.]

12. "*Periodates.*" By C. W. Kimmins, D.Sc., B.A. (Contribution No. IX. from the Laboratory of Gonville and Caius College, Cambridge).

The author, at the suggestion of Mr. Pattison Muir, has re-examined certain periodates of potassium, silver, and sodium, with the object of explaining the discordant results of various observers.

Besides the salt, $Na_2H_3IO_6$, described by Langlois, he has obtained a sodium periodate of the formula $Na_3H_2IO_6$; he also describes a potassium periodate, $K_3HI_2O_9$. He has prepared and analysed the following silver salts:—

Ag_2HIO_5, dark brown.	$AgIO_4$, bright yellow,
$Ag_2H_3IO_6$, dark red.	$Ag_4I_2O_9{\cdot}3OH_2$, light yellow.
$Ag_3H_2IO_6$, slate-coloured.	$Ag_4I_2O_9{\cdot}OH_2$, claret-col'd.
$AgIO_4{\cdot}OH_2$, orange.	$Ag_4I_2O_9$, chocolate-coloured.

13. "*Sulphonic Acids derived from the β-Monohaloid-derivatives of Naphthalene.*" By Henry E. Armstrong and W. P. Wynne, B.Sc.

Experiment having shown that the sulphonic acids obtained from napthalene under conditions by which the occurrence of secondary change—which undoubtedly takes place when sulphuric acid is used as a sulphonating agent—is avoided, differ from those formed by means of sulphuric acid; and that the α-monohaloid derivatives of naphthalene yield isomeric sulphonic acids: it became desirable to study the behaviour of the β-monohaloid-derivatives.

By the action of fuming sulphuric acid at 130° to 140° on β-chloronaphthalene, Arnell (*Bull. Soc. Chim.*, xlv., 184) has obtained two isomeric acids: one of these yields a sulphochloride melting at 129°, which is converted into δ-dichloronaphthalene by distillation with PCl_5; the sulphochloride of the isomeride melts at 109°, and yields ε-dichloronaphthalene.

By acting with SO_3HCl on β-chloronaphthalene in molecular proportions, the authors have also obtained two isomeric acids, which are undoubtedly identical with those discovered by Arnell. The *barium* salt of the chief product, $(C_{10}H_6Cl{\cdot}SO_3)_2Ba{\cdot}4H_2O$, crystallises in laminæ; the *potassium* salt, $C_{10}H_6Cl{\cdot}SO_3K+H_2O$, crystallises in small scales. The isomeric salts, $(C_{10}H_6Cl{\cdot}SO_3)_2Ba$ and $C_{10}H_6Cl{\cdot}SO_3K{\cdot}\frac{1}{2}H_2O$, are much less soluble in water.

β-Bromonaphthalene, in like manner, yields two isomeric acids. The *barium* salt of the chief product, $[C_{10}H_6Br{\cdot}SO_3]_2Ba{\cdot}3\frac{1}{2}H_2O$, and the *potassium* salt,—

$$C_{10}H_6Br{\cdot}SO_3K{\cdot}1\tfrac{1}{2}H_2O,$$

crystallise in thin octagonal scales. The corresponding salts of the isomeric acid are anhydrous and very sparingly soluble in water; the barium salt crystallises in tufts of flat needles, the potassium salt in thin lustrous laminæ.

β-Iodonaphthalene also yields two isomeric acids. The barium salt of the chief product, $[C_{10}H_6I{\cdot}SO_3]_2Ba{\cdot}4\frac{1}{2}H_2O$, and the potassium salt, $C_{10}H_6I{\cdot}SO_3K{\cdot}H_2O$, crystallise in thin hexagonal scales. The salts of the isomeric acid are very sparingly soluble in water; the lead salt,—

$$[C_{10}H_6I{\cdot}SO_3]_2Pb{\cdot}2\tfrac{1}{2}H_2O,$$

crystallises in scales: the barium salt,—

$$[C_{10}H_6I{\cdot}SO_3]_2Ba{\cdot}2H_2O,$$

in white flat needles; and the potassium salt,—

$$C_{10}H_6I{\cdot}SO_3K{\cdot}H_2O,$$

in well-defined laminæ.

Inasmuch as the action takes place between theoretical quantities of the reacting bodies, there can be little doubt that the products result from primary changes: a very small proportion, however—at most 3 or 4 per cent—of the haloid compound, is converted into the acid yielding the less soluble salts. Assuming, as is probable, that the products from chloro-, bromo-, and iodonaphthalene correspond in composition, the proof of the production of ε-diderivatives in this manner is of considerable theoretical importance: although not absolutely placed beyond doubt, there is every reason to believe that ε-dichloronaphthalene is the *symmetrical heteronucleal* $\beta_2\beta_3'$-derivative; and the formation of such derivatives affords a clear indication of the existence of what one of the authors has termed a plane of symmetry in the naphthalene molecule, corresponding to a diagonal passing through two β-positions in the two nuclei of the naphthalene symbol, a more convincing proof of which perhaps is afforded by the complete conversion of β-naphthyl sulphate on heating at 100° into β-naphthol-β-sulphonic acid, which is also an ε-di-derivative (*Ber.*, xv., 203).

14. "*The Decomposition of Potassium Chlorate and Perchlorate by Heat.*" By Frank L. Teed, D.Sc.

The results published in the paper on this subject by Dr. P. F. Frankland and Mr. J. Dingwall in *Proc. Chem. Soc.*, No. 32, as far as they go, entirely confirm certain results obtained by me, and announced in two papers, abstracts of which appeared in *Proc. Chem. Soc.*, Nos. 12 and 16 of the Session 1885 86.

In my latter paper I say that when the salt is very gently heated the decomposition more nearly approximates to the equation $22KClO_3 = 14KClO_4 + 8KCl + 5O_2$, to which Frankland and Dingwall make no reference, the majority

of the results falling within the limits of this equation and of the equation $10KClO_3 = 6KClO_4 + 4KCl + 3O_2$. On adding these two equations together and reducing to the lowest terms, the Frankland-Dingwall equation is obtained, which is merely one of the many equations that could be formed to express intermediate stages of decomposition.

There seems to be an idea among certain chemists that the determination of the evolved oxygen and of the potassium chloride are insufficient data from which to construct an equation, and that it is necessary to directly determine the perchlorate formed; or at all events, the undecomposed chlorate. This idea is erroneous, because it is obvious that for every 74·5 parts of KCl formed there must have been 122·5 of $KClO_3$ decomposed; and of the resulting 48 parts of oxygen, what is not evolved in the free state *must* have gone to form perchlorate. Any determinations of the $KClO_3$ and $KClO_4$ are therefore unnecessary. To give the results in my second paper (the paper was not published and the data do not appear in the abstract).

No.	$KClO_3$ taken. Grms.	Oxygen evolved. Per cent.	KCl formed. Per cent.	Amount of oxygen to 74·5 of KCl.
1	4·3782	3·60	11·58	23·16
2	6·865	1·27	4·73	20·00
3	9·291	1·61	6·00	19·99
4	4·759	1·60	6·14	19·41
5	4·4905	1·47	4·84	22·63
6	6·050	0·80	2·18	27·34

I heated more gently and carefully than Frankland and Dingwall, and so obtained a higher yield of perchlorate and less free oxygen than they appear to have done. The equation $22KClO_3 = 14KClO_4 + 8KCl + 5O_2$ demands 20 parts of oxygen to 74·5 of KCl.

I was very careful to point out in my former paper that no equation represents the decomposition of potassium chlorate, and only proposed the two I have submitted as marking the usual limits of the final products.

The results with perchlorate given in my second paper were:—

No.	$KClO_4$ taken. Grms.	Oxygen lost. Per cent.	KCl formed. Per cent.	Amount of oxygen to 74·5 KCl.
1	2·4355	3·10	2·97	77 76
2	3·8825	4·47	4·41	75·59
3	1·850	7·30	7·82	69·55
4	1·217	35·21	40·33	65·04

Frankland and Dingwall have failed to notice the first high ratio of oxygen to KCl, by again driving off too much oxygen, and to this extent their results are incomplete.

It is obvious that perchlorate of potassium, when it loses more oxygen than expressed by the equation—

$$KClO_4 = KCl + 2O_2,$$

must be forming a lower oxide of potassium chloride; and the only such oxide possible under the circumstances is the chlorate. Hence the necessity for determining the chlorate formed disappears.

Discussion.

Dr. Percy Frankland said that he regretted Dr. Teed was not present at the reading of his and Mr. Dingwall's paper, for he would then have clearly understood that they had in no way arrogated to themselves the originality of the experiments, which undoubtedly belonged to Dr. Teed. Their experiments had been made with the view of testing the correctness of Dr. Teed's results, and they had endeavoured to place these results beyond the possibility of doubt, not only by taking special precautions in the method of decomposing the salts, but also by actually determining the proportion of chlorate formed in the decomposition of perchlorate, and the proportion of perchlorate in the decomposition of chlorate.

15. "*The Formation of Ethylic Cyanacetoacetate.*" By Dr. J. William James, University College, Cardiff.

If 50 grms. (1 mol. proportion) of ethylic monochloracetoacetate be mixed with 40 grms. (2 mol. proportions) of potassium cyanide, and 600 c.c. of 99½ per cent alcohol, a reaction takes place slowly at the ordinary temperature, the product consisting of ethylic potassium cyanacetoacetate, $CH_2(CN)\cdot CO\cdot CHK\cdot COOEt$.

If an aqueous solution of this salt be acidified with dilute chlorhydric acid, *ethylic cyanacetoacetate* separates as a colourless oil, which solidifies, if cooled, to a mass of fine silky needles, melting at 26·5° C. It cannot be distilled under ordinary pressure.

Ethylic dichloracetoacetate and potassium cyanide interact under the same conditions in a totally different manner, forming *potassium dichloracetate* and ethylic acetate.

16. "*The Relation of Diazobenzene Anilide to Amidoazobenzene.*" By R. J. Friswell and A. G. Green.

In a previous communication to the Society (*Trans.*, 1885, 917) we have attempted to give a partial explanation of the manner in which the isomeric change of diazobenzene anilide into amidoazobenzene takes place. We have shown that, in all probability, previous to the conversion, a resolution of the molecule of the anilide into diazobenzene and aniline is brought about by the acid present, and that these bodies then reunite in a different manner to form amidoazobenzene.

Further than this we could not go, for it still appeared to us a mystery how it was possible that the anilide could be formed under conditions which ultimately led to its resolution and recombination in a new form, for example, when 1 mol. proportion of HCl is present.

This last difficulty has now been cleared away by the suggestions lately put forward by O. Wallach (*Annalen*, ccxxxv., 233), and the whole reaction now appears perfectly clear and straightforward. Diazobenzene combines with aniline *at once* when no excess of mineral acid is present to form diazobenzene anilide; the presence of free mineral acid, however, lessens the tendency to displacement of the amidogen hydrogen, and thus prevents (more or less completely according to the quantity of acid present) the formation of the anilide: under these conditions the tardier tendency to displacement of the para-hydrogen of the nucleus now comes into play and amidoazobenzene is *very slowly* formed. If only 1 mol. proportion of HCl is present, the anilide is formed, but not quantitatively, the acid, though not sufficient to entirely counterbalance the tendency to displacement in the NH_2, yet keeps apart a certain quantity of the diazobenzene and aniline, which in course of time interact to form amidoazobenzene and are consequently removed. The conditions are thus altered, and equilibrium is again established by the resolution of a further quantity of the anilide, the constituents of which slowly combine as before to produce amidoazobenzene. In this way the whole of the anilide is slowly resolved and the products recombined to form the compound, which, although the most stable under the conditions, requires a considerable time for its production, thus allowing of the intermediate production of a more quickly formed but less stable body.

17. "*Note on Wallach's Explanation of the Isomeric Transformation of Diazoamidobenzene into Amidoazobenzene.*" By R. Meldola, F.R.S.

In a recent paper published by Wallach (*Annalen*, ccxxxv., 233), that author, who has contributed such valuable results to the chemistry of the azo- and diazo-compounds, puts forward an explanation of the transformation of diazoamido- into amidoazobenzene, which seems to me to call for some comment. I should have been unwilling to call in question any opinion emanating from such a well-known authority had it not been for the somewhat dogmatic statement,—that in the opinion of the writer the question now appeared to have received its final dismissal ("*ihre endgültige Erledigung*"), As such a statement is calculated to induce a feeling of false security on the part of those who have paid attention to

this most interesting case of isomeric change, I take the opportunity of putting upon record my own conviction that the explanation advanced does not materially contribute to the solution of the problem. According to Wallach's view the reason why amidoazobenzene is not formed as the first products is because the aniline upon which the diazo-salt acts is for the most part free, *i.e.*, its NH_2-group is not saturated, and the diazobenzene residue can therefore readily enter the group in place of one H-atom. But when the diazoamido-compound is in presence of excess of acid (or of easily decomposable salts) it becomes resolved into its constituents, and these then reunite in a different way, because the NH_2-group is saturated and the diazobenzene residue prefers entering the nucleus (in the para-position). The aniline *salt* is in this case, according to the author, in the same condition as a tertiary amine or a phenol. A little consideration will, however, show that the known facts will not bear this interpretation, for diazoamidobenzene is *always* the first product whenever diazobenzene chloride acts upon any mixture of aniline and aniline hydrochloride, and this shows a distinct preference for the amido-hydrogen of the free aniline to be first displaced. In the presence of aniline hydrochloride, on the view that the acid of this salt decomposes the diazoamido-compound into its constituents, we have therefore a mixture of diazobenzene chloride, aniline hydrochloride, and free aniline, *i.e.*, the conditions are precisely the same as at the commencement of the experiment. Why under these reproduced conditions the diazobenzene chloride should now prefer attacking the para-H-atom of the aniline hydrochloride instead of the amido-H of the aniline, remains, after the proposed "explanation," as great a mystery as ever.

At the next meeting on March 3 there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Colouring-matter of *Drosera Whittakeri*," by Prof. E. H. Rennie, D.Sc.

"Anhydracetone Benzil," by F. R. Japp, F.R.S., and Cosmo Innes Burton, B.Sc.

"Condensation of Benzil with Ketones," by the same.

"Constitution of Glycosine," by F. R. Japp, F.R.S., and E. Cleminshaw, M.A.

"Diphenylglyoxaline and its Homologues, by F. R. Japp, F.R.S.

"Dehydracetic Acid," by Dr. W. H. Perkin, Junr.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 3, January 17, 1887.

The Laws of the Absorption of Light in Crystals, and a Novel Method for Distinguishing in a Crystal Certain Absorption-Bands belonging to Different Bodies.—H. Becquerel.—1. The absorption-spectrum observed through a crystal varies with the direction of the rectilinear luminous vibration which propagates itself in this crystal. 2. The bands or rays observed through the same crystal have, in the spectrum, fixed positions, their intensity alone varying. 3. For a given band or ray there exist in the crystal three rectangular directions of symmetry, according to one of which the band generally disappears, so that for a suitable direction of the luminous vibrations the crystal no longer absorbs the radiations corresponding to the region of the spectrum where the band in question appeared. These three directions may be called the principal directions of absorption, relative to this band. 4. In the orthorhombic crystals, by a necessary consequence of crystalline symmetry, the principal directions of absorption of all the bands coincide with the three axes of symmetry. We may thus observe three principal absorption-spectra. In uniaxial crystals the number of absorption-spectra is reduced to two. 5. In clinorhombic crystals one of the principal directions of absorption of each crystal coincides with the only axis of symmetry; the two other principal rectangular directions of each band may be found variously disposed in the plane normal to this axis. Most commonly these principal directions are very near to the principal corresponding directions of optical elasticity. 6. In various crystals the characters of the absorption phenomena differ strikingly from those which we might expect to find after an examination of the optical properties of the crystal. We have just seen that in clinorhombic crystals the principal absorption directions of certain bands were completely different from the axes of optical elasticity of the crystal for the corresponding radiations. If we examine this anomaly we perceive that the crystals manifesting these effects are complex bodies, formed of various matters, one, or sometimes several, of which absorb light and give each different absorption-bands. Now M. de Senarmont has shown that the geometric isomorphism of certain substances does not necessarily involve identity of optical properties, and in particular in the directions of the axes of optical elasticity in relation to the geometric directions of the crystal. In a crystal containing a mixture of isomorphous substances each substance brings its own influence, which may be made to predominate in turn according to the proportions of the mixture. We may, therefore, admit that the molecules of each substance enter into the crystal retaining all the optical properties which they would have if each crystallised separately. The principal directions of optical elasticity are given by the resultant of the actions which each of the component substances exerts on the propagation of light, whilst the absorption of a given region of the spectrum is due to a single one of these substances, and may have for its directions of symmetry the directions which it would have in the absorbing molecule supposing it isolated. It may happen that these directions do not coincide with the axes of optical elasticity of the compound crystal. If such is the cause of the anomaly of certain principal directions of absorption, the bands which present these anomalies must belong to substances different from those which yield bands having other principal directions of absorption. If so, we are in possession of a novel method of spectral analysis which permits us to distinguish in certain crystals bands belonging to different matters, isomorphous, but not having the same optical properties. Two bands appearing in a crystal with common characters but presenting in another crystal characters essentially different must also be ascribed to two different bodies.

Formation-Heat of certain Sodium Alcoholates.—M. de Forcrand.—Not capable of useful abstraction.

On certain Combinations of Stannic Oxide.—A. Ditte.—The gelatinous stannic acid obtained on decomposing stannic chloride by an alkali dissolves readily in hot sulphuric acid diluted with 8 to 10 vols. of water. The solution deposits crystals having the composition $SnO_2(SO_3HO)$. Gelatinous stannic acid, air-dried, becomes a hard vitreous mass, which if finely powdered dissolves entirely in a hot mixture of equal parts of sulphuric acid and water. The solution deposits crystals of the same composition as the former. The pulverulent metastannic acid obtained by the action of tin upon nitric acid dissolves in hot sulphuric acid diluted with double its volume of water, but more slowly. The compound formed has still the same composition. Anhydrous stannic oxide prepared by igniting any of the hydrates for a few minutes is attacked very slowly by sulphuric acid at a heat near its boiling-point. The resulting salt has still the same composition. If the acid is not in excess,

the liquid, on the addition of an excess of anhydrous ether, deposits a precipitate of the composition $SnO_2(SO_3HO)$. With selenic acid a similar compound is obtained more readily.

Action of certain Non-Metallic Elements upon Solutions of Silver and Copper Nitrates.—J. B. Senderens.

Composition of the Grain of Starch.—E. Bourquelot.—The grain of starch does not consist of one chemical species, nor of two such (granulose or amylose), but of a larger number of carbo-hydrates.

MISCELLANEOUS.

Sanitary Institute of Great Britain.—The Right Hon. G. Sclater Booth, M.P., has accepted the Presidentship of the Congress of this Institute, to be held at Bolton in September next.

Soap and Alkali.—We are requested to state that a special course of six lectures on this subject will be commenced by Prof. Meldola, F.R.S., on Wednesday evening, March 23, at 7 o'clock. The syllabus of the course can be had on application at the Finsbury Technical College, Leonard Street, City Road, E.C.

MEETINGS FOR THE WEEK.

MONDAY, 28th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Building Materials," by W. Y. Dent, F.C.S.
TUESDAY, March 1st.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8. "The Colonial and Indian Exhibition," by Edward Cunliffe Owen, C.M.G.
—— Royal Medical and Chirurgical, 8. (Anniversary).
WEDNESDAY, 2nd.—Society of Arts, 8. "The Cultivation of Tobacco in England," by E. J. Beale.
THURSDAY, 3rd.—Royal, 4 30.
—— Pathological, 8.30.
—— London Institution, 6.
—— Royal Institution, 3. "The Critics of the Age of Anne," by Edmund Gosse, M.A.
—— Chemical, 8. "The Colouring-matter of Drosera Whittakeri," by Prof. Rennie. "Anhydracetonebenzil," by F. R. Japp and C. I. Burton, B.Sc. "Condensation of Benzil with Ketones," by the same. "The Constitution of Glycosine," by F. R. Japp and E. Cleminshaw, M.A. "Diphenylglyoxaline and its Homologues," by F. R. Japp. "Dehydracetic Acid," by Dr. W. H. Perkin, Jun.
FRIDAY, 4th.—Royal Institution, 9. "Brain Surgery in the Stone Ages," by Victor Horsley, F.R.S., F.R.C.S.
—— Society of Arts, 8. "Our Trade Routes to the East," by Major-General Sir F. J. Goldsmid, K.C.S.I., C.B.
—— Geologists' Association 8.
SATURDAY, 5th.—Royal Institution, 3. "Sound," by the Right Hon. Lord Rayleigh.

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THE CHEMICAL NEWS.

Vol. LV. No. 1423.

GENESIS OF THE ELEMENTS.*

By WILLIAM CROOKES, F.R.S., V.P.C.S.

(Concluded from p. 87.)

But it may be asked, What is the bearing of all this upon the great question of the genesis of the elements? Have we chemists merely discovered some new "elements," or found out that a body hitherto held to be simple is in reality complex? We have, I submit, done something decidedly different. If a metal which is found to have a fixed atomic weight is discovered to be a compound or a mixture, our best test for recognising an element, so-called, has melted away! Hitherto it has been considered that if the atomic weight of a metal, determined by different observers, setting out from different compounds, was always found to be constant (within, of course, the limits of experimental error), then such metal must rightly take rank among the simple or elementary bodies. We learn from Nordenskiold's gadolinium that this is no longer the case. Again, we have here wheels within wheels. Gadolinium is not an element, but a compound, or rather, perhaps, a mixture of yttrium, erbium, and ytterbium. We have shown that yttrium is a complex of five or more new constituents. And who shall venture to gainsay that each of these constituents, if attacked in some different manner, and if the results were submitted to a test more delicate and searching than the radiant-matter test, might not be still further divisible! Where, then, is the actual ultimate element? As we advance it recedes like the tantalising mirage lakes and groves seen by the tired and thirsty traveller in the desert. Are we in our quest for truth to be thus deluded and baulked? The very idea of an element, as something absolutely primary and ultimate, seems to be growing less and less distinct.

But we have by no means done with the rare earths and their lessons. How is it that these bodies are found, as we actually find them, associated in certain rare minerals such as samarskite and gadolinite, but occurring only in a few localities? This fact is hard to account for on the ordinary theories of the origination of the elements.

I venture provisionally to conclude that our so-called elements or simple bodies are, in reality, compound molecules. To form a conception of their genesis I must beg you to carry your thoughts back to the time when the visible universe was "without form and void," and to watch the development of matter in the states known to us from an antecedent something. What existed anterior to our elements, before matter as we now have it, I propose to name *protyle*.†

But how can we suppose the protyle, or fire-mist, converted into the atomic condition? In amorphous matter we recognise a tendency to aggregation not to be identified with gravitation, since it is manifested among finely-divided matter, whether suspended in a medium of a specific gravity superior, equal, or inferior to its own. This agglutinative action is familiar to observers of natural phenomena. Clouds contracting to that appearance known as a mackerel sky; particles of carbon floating in the air, collecting, and ultimately falling as "blacks"; chemical precipitates, at first finely amorphous, but gradually becoming flocky, granular, and crystalline; vortex rings, suddenly quickening out of amorphous smoke;—all these, and many more, exemplify that universal formative principle in nature which I suggest first made itself manifest in the condensation of protyle into atomic matter.

A few weeks ago in this theatre Sir William Thomson asked you to travel back with him an imaginary excursion of about twenty million years. He pictured to you the moment immediately before the birth of our sun, when the Lucretian atoms rushed from all parts of space with velocities due to mutual gravitation, and, clashing together, formed in a few hours an incandescent fluid mass, the nucleus of a solar system with thirty million years of life in it. I will ask you to accompany me to a period even more remote,—to the very beginning of time, before even the chemical atoms had consolidated from the original *protyle*. Let us imagine that at this primal stage all was in an ultra-gaseous state—a state differing from anything we can now conceive in the visible universe.

Now unless the expression "fire-mist" and the supposition that pristine matter was once in an intensely heated condition* are quite misleading and baseless, we have to deal with a process analogous to cooling. This operation, probably internal, reduces the temperature of the cosmic *protyle* to a point at which the first step in granulation takes place; matter as we know it comes into existence, and atoms are formed. As soon as an atom is formed out of *protyle* it is a store of energy, kinetic (from its internal motions) and potential (from its tendency to coalesce with other atoms by gravitation or chemically). To obtain this energy the neighbouring *protyle* must be laid under contribution, *i.e.*, must be refrigerated by it, thereby accelerating the subsequent formation of other atoms. With the birth of gravitating matter, rushing suddenly together from every point of space, we thus get Sir William Thomson's incandescent mass which is presently to cool down into a solar system. We cannot tell if electricity existed prior to the origin of the atomic condition of matter, but with the formation of atomic matter the other forms of energy which require matter in order to manifest themselves, begin to act, amongst others that form of energy which has for one of its factors that which we now speak of as atomic weight.

We have now to seek how protyle was converted not into one only kind of matter but into many. If we recognise that it contained within itself the potentiality of all atomic weights, how did these potentialities become

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* A Lecture delivered at the Royal Institution, on Friday Evening, February 18th, 1887.

† We require a word, analogous to protoplasm, to express the idea of the original primal matter existing before the evolution of the chemical elements. The word I have ventured to use for this purpose is compounded of πρό (*earlier than*) and ὕλη (*the stuff of which things are made*). The word is scarcely a new coinage, for in the "Wisdom of Solomon" (xi., v. 17) we read:—"Thy almighty hand, that created the world—ἐξ ἀμόρφου ὕλης—out of formless stuff," the word here rendered "stuff" being in the original ὕλης, from which I have ventured to coin the word "protyle." Six hundred years ago Roger Bacon wrote in his *De Arte Chymiæ*, "The elements are made out of ὕλη, and every element is converted into the nature of another element." Professor Huxley reminds me that ὕλη, in the general sense of material substance, was first used by Aristotle, in whose works it is of very frequent occurrence. In fact the fundamental distinction in his Physical Philosophy is between ὕλη, or *matter*, and εἶδος, or *form*, which last pretty nearly answers to what we should call the sum total of the qualities, powers, and tendencies of a thing—or of forces as the cause of these. In the metaphysics and elsewhere Aristotle distinguishes (1) Πρώτη ὕλη, "Materia Prima," or matter undifferentiated into elements, without form, in fact, and consequently ἀγνωστος, unknown and unknowable, and (2) ἐσχατη ὕλη, secondary or formed matter, such as earth, or metal, or water, or any other raw material with which we are familiar.

* I am constrained to use words expressive of high temperature but I confess I am unable clearly to associate with *protyle* the idea of hot or cold. *Temperature*, *radiation*, and *free cooling* seem to require the periodic motions that take place in the chemical atoms; and the introduction of centres of periodic motion into protyle would involve its being so far changed into chemical atoms. Probably the first operation was more analogous to the formation of vortex rings than to a reduction of temperature.

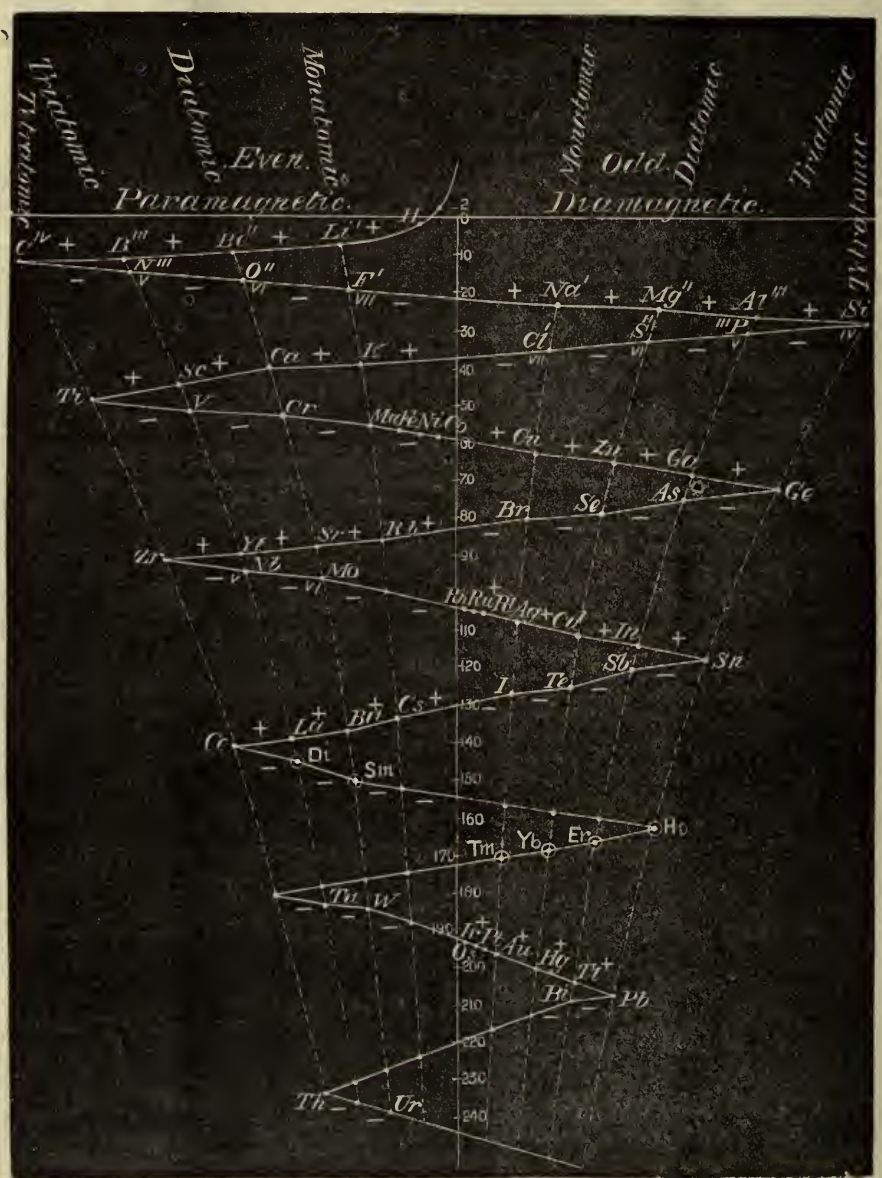
actual? We may here call to mind the suggestion of Dr. E. J. Mills, that our elements are the result of successive polymerisations during the cooling process. We shall also derive much assistance from a method of illustrating the periodic law proposed by my friend Prof. Emerson Reynolds, of the University of Dublin.

I must call your attention to a diagram (Fig. 5) in

The chemical elements are arranged in order, according to their atomic weights, on the centre vertical line which is divided into equal parts.

Following the curve from hydrogen downwards, we see that the elements forming the eighth group of Mendeleeff's arrangement are situate near three of the ten nodal points. This eighth group is divided into the three triplets—iron,

Fig. 5.


Triatomic
Diatomic
Monatomic
Even.
Paramagnetic.
Monatomic
Odd.
Diamagnetic.
Diatomic
Triatomic
Tetratomic
Li' + Be'' + B''' + C''''
N''' O'' F' Ne
Na' + Mg'' + Al''' + Si''''
P''' S'' Cl' A
K' + Ca'' + Sc''' + Ti''''
V''' Cr'' Mn'' Fe'' Ni'' Co''
Cu' + Zn'' + Ga''' + Ge''''
As''' Se'' Br'
Rb' + Sr'' + Y''' + Zr''''
Nb''' Mo''
Ru Rh Pd Ag' Cd'' In''' Sn''''
Sb''' Te'' I'
Cs' + Ba'' + La''' + Ce''''
Di Sm
Ho Er Yb Tm
Ta W
Os Ir Pt Au Hg Tl' Pb''
Bi'''
Th Ur
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240

which I have slightly modified the original design of Prof. Reynolds. I have represented the pendulum swing as gradually declining in amplitude according to a mathematical law. I have further interposed between cerium and lead another half-swing of the pendulum. This renders the oscillations more symmetrical and brings gold, mercury, thallium, lead, and bismuth to the side where they are fully in harmony with members of previous groups.

nickel, and cobalt; rhodium, ruthenium, and palladium; iridium, osmium, and platinum.

These bodies are interperiodic because their atomic weights exclude them from the small periods into which the other elements fall, and because their chemical relations with some members of the neighbouring groups show that they are probably interperiodic in the sense of being in transition stages.

Notice how accurately the series of like bodies fits into

this scheme. Beginning at the top, run the eye down analogous positions in each oscillation, taking either the electro-positive or electro-negative swings :—

Any well-defined element may be likened to a platform of stability, connected by ladders of unstable bodies. In the first coalescence of the primitive stuff there would be

Table II.

Vertical Series of the Elements.

Even.							Odd.						
iv.	iii.	iii. v.	ii.	ii. vi.	i.	i. vii.	i. vii.	i.	ii. vi.	ii.	iii. v.	iii.	iv.
C	B	N	Be	O	Li	F	Cl	Na	S	Mg	P	Al	Si
Ti	Sc	V	Ca	Cr	K	Mn	Br	Cu	Se	Zn	As	Ga	Ge
Zr	Yt	Nb	Sr	Mo	Rb	—	I	Ag	Te	Cd	Sb	In	Sn
Ce	La	—	Ba	Sm	Cs	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	Au	—	Hg	Bi	Tl	Pb

Notice, also, how orderly the metals discovered by spectrum analysis fit in their places—gallium, indium, and thallium ; rubidium and cæsium.

The symmetry of nearly all this series proclaims at once that we are working in the right direction. Much also may be learned from the anomalies here visible. A few bodies, such as didymium, erbium, thulium, and ytterbium, are out of place, and require to have their atomic weights re-determined.

The more I ponder over the arrangement of this zigzag curve, the more I become convinced that he who fully grasps its meaning holds the key to unlock some of the deepest mysteries of creation. As Mr. Browning puts it in his "Parleyings"—"'Tis Man's to explore Up and down, inch by inch, with the taper his reason." Let us batter at the door of the Unknown and do our utmost to get a glimpse of some few of the secrets so darkly hidden.

Let us return in imagination to præ-geological ages, before the sun himself had been aggregated from the original protyle. We require two very reasonable postulates : let there be granted an antecedent form of energy having periodic cycles of ebb and swell, rest and activity. Let there also be granted an internal action akin to cooling operating slowly in the protyle. The first-born element would, in its simplicity, be most nearly allied to protyle. This is hydrogen, of all known bodies the simplest in structure and of the lowest atomic weight. For some time hydrogen would be the only existing form of matter (in our sense of the term). Between hydrogen and the next-formed element there would be a gap in time, and in the interval the element standing next in order of simplicity would gradually be approaching its birth-point. In this interval we may suppose that the evolutionary process soon to determine the birth of a new element would fix likewise its atomic weight, its affinities, and its chemical position.

In this genesis of the elements the longer the time taken up in the cooling-down process during which the hardening of protyle into atoms takes place, the more sharply defined would be the resulting elements ; whilst the more rapid and the more irregular the cooling the more closely the resulting bodies would fade into each other by almost imperceptible degrees. Thus we may conceive that the succession of events which gave rise to such groups as platinum, osmium, and iridium,—palladium, ruthenium, and rhodium,—iron, nickel, and cobalt, —might have produced only one element in each of these three groups if the process had been greatly prolonged. And conversely, had the rate of cooling been much more rapid, elements might have originated still more nearly identical than are nickel and cobalt. Thus may have arisen the closely allied elements of the cerium, yttrium, and similar groups. In fact, we may regard the collocation of the minerals of the class of samarskite and gadolinite as a kind of cosmical lumber-room where elements in a state of arrested development—the unconnected missing links of inorganic Darwinism—are gathered together.

formed the smallest atoms ; these would then unite, forming larger groups ; the gaps between the several stages would gradually be bridged over, and the stable element appropriate to that stage would absorb, so to speak, the unstable rungs of the ladder which led up to it. It may be questioned whether there is an absolute uniformity in the mass of every ultimate atom even of one and the same chemical element. Probably our atomic weights merely represent a mean value around which the actual atomic weights of the atoms vary within certain narrow limits. When, therefore, we say that, *e. g.*, the atomic weight of calcium is 40, the actual fact may well be that whilst the majority of the calcium atoms really have the atomic weight of 40, some are represented by 39·9 or 40·1, a smaller number by 39·8 or 40·2, and so on. The properties which we perceive in any element are thus the mean of a number of atoms differing among themselves very slightly, but still not identical.* Is this the true meaning of Newton's "old worn particles" ?

That this speculation, hazardous as it may seem, is in some respects supported by the experimental results above described will, I think, be admitted. It seems to me that the hypothesis I have just suggested, if taken in conjunction with the diagram, Fig. 5, enables us to proceed a step or two further along the track of the evolution of the elements. We may trace in the undulating curve the action of two forms of energy, the one acting vertically and the other vibrating to and fro like a pendulum. Let the vertical line represent temperature gradually sinking through an unknown number of degrees from the dissociation-point of the first-formed element downwards to the dissociation-point of the last member of the scale.

But what form of energy is figured by the oscillating line? We see it swinging to and fro to points equidistant from a neutral centre. We see this divergence from neutrality confer atomicity of one, two, three, or four degrees as the distance from the centre increases to one, two, three, or four divisions. We see the approach to or the retrocession from this same neutral line deciding the electro-negative or electro-positive character of each element ; those on the retreating half of the swing being positive, and those on the approaching half negative. In short, we are led to suspect that this oscillating power must be closely connected with the imponderable matter, essence, or source of energy we call electricity.

Let us now return to the period just preceding the birth of the first element. Before that time matter as it now is manifested did not exist. We can no more conceive of matter without energy than of energy without matter ; indeed, from one point of view the two are convertible terms. Let us assume that simultaneously with the creation of atoms all those attributes which enable us to

* I venture to suggest that the heavier and lighter atoms formed from the protyle may have been partially sorted out by a process in nature somewhat analogous to the fractionation which has been already described. Such a sorting out would be effected chiefly whilst atomic matter was condensing from the primal state ; but it may also have been carried on during geological ages in the wet way by successive solutions and re-precipitations of the various earths.

discriminate one form of matter from another, start into being endowed with energy.

Our pendulum begins its swing from the electro-positive side: lithium, next to hydrogen in the simplicity of its atomic weight, is now formed, followed by glucinum, boron, and carbon. Each element, at the moment of birth, takes up definite quantities of electricity, and on these quantities its atomicity depends.* Thus are fixed the types of the monatomic, diatomic, triatomic, and tetratomic elements.

It has been pointed out by Dr. Carnelley that "those elements belonging to the even series of the periodic classification are always paramagnetic, whereas the elements belonging to the odd series are always diamagnetic." Now in our curve the even series to the left, so far as has been ascertained, are paramagnetic, whilst, with a few exceptions, all to the right are diamagnetic. The strongly magnetic group, iron, manganese, nickel, and cobalt, lie close together on the proper side. But the interperiodic groups, of which palladium and platinum are respectively examples, are supposed to be feebly magnetic. If this can be verified they form exceptions which have yet to be explained. Oxygen, which weight for weight is even more strongly magnetic than iron, lies near the beginning of the curve, whilst at the opposite end come the powerfully diamagnetic metals, bismuth and thallium.

We come now to the return or negative part of the swing: nitrogen appears and shows instructively how position governs the mean dominant atomicity. Nitrogen occupies a position immediately below boron, a triatomic element, and, therefore, nitrogen is likewise triatomic. But nitrogen also follows upon carbon, a tetratomic body, and occupies the fifth position if we count from the place of origin. Now these seemingly opposing tendencies are beautifully harmonised by the endowment of nitrogen with a double atomicity, its atom being capable of acting either as a tri- or as a pentatomic element. With oxygen (di- and hexatomic) and fluorine (mon- and heptatomic) the same law holds good, and one half oscillation of the pendulum is completed. Passing the neutral line again, we find successively formed the electro-positive bodies sodium (monatomic), magnesium (diatomic), aluminium (triatomic), and silicon (tetratomic).

Here we may notice a curious coincidence; at the beginning of this part of the curve stands carbon, the most ubiquitous element in the organic world. At the end, in opposition, stands silicon, the most commonly occurring element in the inorganic sphere. Further, as we move towards the median line, carbon is successively followed by nitrogen, oxygen, and fluorine, all entering into organic compounds and all gaseous in the free state. If we work back from silicon we find aluminium, magnesium, and sodium all much less disposed to volatility, and all very prominent members of the mineral kingdom.

The first complete swing of the pendulum is accomplished by the birth of the three electro-negative elements, phosphorus, sulphur, and chlorine; all three, like the corresponding elements on the opposite homeward swing, having at least a double atomicity, depending on position.

Let us pause and examine the results. We have now formed the elements of water, of air, of ammonia, of carbonic acid, of plant and animal life; we have phosphorus for the brain, salt for the sea, clay and sand for the solid earth; two alkalies, an alkaline earth, an earth, along with their carbonates, borates, nitrates, fluorides, chlorides, sulphates, phosphates, and silicates, sufficient, it may be said, for animal and vegetal life, and for a world not so very different from that in which we live and move.

Again let us follow our pendulum. After the formation of chlorine this pendulum touches the neutral line, and is in the same position as in the beginning. Had everything remained as at first the next element to appear would again have been lithium, and the original cycle would have been eternally repeated, producing again and again the same fifteen elements. The conditions, however, are no longer the same: time has elapsed and the form of energy represented by the vertical line has declined; in other words, the temperature has sunk, and the first element to come into existence when the pendulum starts for its second oscillation is not lithium, but the metal next allied to it in the series, *i.e.* potassium, which may be regarded as the lineal descendant of lithium, with the same hereditary tendencies, but with less molecular mobility and a higher atomic weight.

Pass along the curve and in nearly every case the same law holds good. Thus the last element of the first complete vibration is chlorine. In the corresponding place in the second vibration we have not an exact repetition of chlorine but the very similar body bromine, and when the same position recurs for a third time we see iodine. I need not multiply examples. I may, however, point out that we have here a phenomenon which reminds us of alternating or cyclical generation in the organic world, or we may perhaps say of atavism, a recurrence to ancestral types, somewhat modified.

In this evolutionary scheme it cannot be expected that the potential elements should all be equal to each other. On the contrary, many degrees of stability will be represented, and if we look with a scrutinising eye we shall see our old friend the "missing link," coarse enough to be detected in the groups comprising such bodies as iron, nickel, and cobalt; palladium, ruthenium, and rhodium; iridium, osmium, and platinum; whilst in a more subtile form these missing links present themselves as representatives of the differences which I have suggested between the atoms of the same chemical element.

On the even or para-magnetic half of the swing the energy appears to have acted in a very irregular manner, whilst on the odd, or dia-magnetic half, there is considerable regularity. Thus, between the extreme odd elements, silicon (28), germanium (73), tin (118), a missing element (163), and lead (208) there is a difference of exactly 45 units, rendering this half of the curve remarkably symmetrical. On the even side the differences are 36, 42, 51, 39, and 53 (assuming an atomic weight of 180 for a missing element between cerium and thorium). At first sight these differences appear to follow no law, but they gain interest when we see that the mean difference of these figures is 44·2—almost exactly the same as that on the odd side of the curve.

From this uniformity of difference—actual on the one side and average on the other—we may fairly infer that whilst on the odd side there has been little or no variation in the force symbolised by the vertical line, minor irregularities have been the rule on the even side. Or, in other words, the fall of temperature has been very uniform on the odd side—where, accordingly, we see that every original element represents a well marked group, sodium, magnesium, aluminium, silicon, phosphorus, and chlorine; whilst on the even side the temperature has fallen with considerable fluctuations, thus preventing the formation here of any well-marked groups of elements, excepting those of which lithium and glucinum are the leading types.

Having thus detected irregularities in the fall of temperature in the protyle, we may next ask is there any fluctuation in the force represented by the pendulum-movement? This movement I have assumed to be connected with electrical energy. The earliest-formed ele-

* "Nature presents us with a single definite quantity of electricity. . . . For each chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte, which is the same in all cases."—G. Johnstone Stoney, "On the Physical Units of Nature."—*British Association Meeting*, 1874, Section A. *Phil. Mag.*, May, 1881.

"The same definite quantity of either positive or negative electricity moves always with each equivalent ion, or with every unit of affinity of a multivalent ion."—Helmholtz, Faraday Lecture, 1881.

"Every monad atom has associated with it a certain definite quantity of electricity; every dyad has twice this quantity associated with it; every triad three times as much, and so on."—O. Lodge, "On Electrolysis," *British Association Report*, 1885.

ments are those in which chemical energy is at a maximum; as we descend the scale the affinities become feebler and the chemism grows more and more sluggish. In part this change may be due to the circumstance that the elements generated at a reduced temperature no longer possess great molecular mobility. But it is also extremely probable that the chemism-forming energy is itself dying out like the fires of the cosmic furnace. I have attempted to symbolise this gradual fading by a decrease in the amplitude of vibration.

The figures representing the scale of atomic weights may be supposed to represent, inversely, the scale of a gigantic pyrometer plunged into a cauldron where the elements of suns and worlds are undergoing formation. As the heat sinks, the elements generated increase in density and atomic weight. Below the formation-point of uranium the temperature will probably permit of the earlier-born elements of forming combinations among themselves, and we shall witness, *e.g.*, the birth of water, and the formation of those known compounds the dissociation of which is not beyond the powers of our terrestrial sources of heat.

Turning to the upper portion of the diagram we see that there is little room for elements of a lower atomic weight than hydrogen. But let us pass "through the looking-glass" and cross the zero line. What shall we find on the other side? Dr. Carnelley asks for an element of negative atomic weight; and here is ample room and verge enough for a shadow series of such unsubstantialities, leading, perhaps, to that "Unseen Universe" which two eminent physicists have discussed. Helmholtz says that electricity is probably as atomic as matter;* is electricity one of the negative elements? and the luminiferous ether another? Matter, as we now know it, does not here exist; and the forms of energy which are apparent in the motions of matter are as yet only latent possibilities.

A genesis of the elements such as is here sketched would not be confined to our little solar system, but would probably follow the same general sequence of events in every centre of energy now visible as a star.

It may be said that so far I have proved nothing. But I may submit that at least I have shown the improbability of the persistence of the ultimate character, and the eternal self-existence, the fortuitous origin, and the simultaneous creation of the elements. The analogy of these elements with the organic radicles, and still more with living organisms, constrains us to suspect that they are compound bodies, springing from a process of evolution. We have drawn corroborative evidence from the distribution and the association of the rare earths, evidence which seems to be converging to the point of assuming a direct character. Led by the great law of continuity I have ventured to suggest a process by which our elements may have been originated. I do not say *must* have been originated, for no one can be better aware than I am how much remains to be done before this great, this fundamental question can be finally solved. I earnestly hope that others will take up the task, and that chemistry, like biology, may find its Darwin.

If we consider the position we occupy with reference to the primary questions of chemistry, we might compare research to a game of chess. Man, the investigor, is playing, not with Satan for his soul, but with Nature for knowledge and power. Each element has its allotted moves on the great board of the universe; some of them dependent solely on themselves, and others on the interaction of the adjacent elements. Some of our elements may be compared to pawns, others to knights, bishops, or castles. The game is fearfully unequal. Our antagonist knows the power and the limitations of every piece, all the laws of the game, all possible moves, and is merciless in exacting penalty for errors. We experimentalists know nothing but what we have learned in countless losing games. But our knowledge is increasing. Nature no longer gives us fool's mate. The struggle becomes more obstinate, more exciting, we come upon new gambits, new combinations, and though still checkmated at the last, we take a few pawns, perhaps even a piece or two. Such partial successes were achieved when Lavoisier introduced the use of the balance and developed the theory of combustion; when Dalton put forward the atomic theory; when Davy decomposed the alkalies; when Wöhler effected the synthesis of urea; and when Faraday first liquefied a gas. On such and many similar occasions I can imagine our antagonist becoming thoughtful.

But suppose we one day win the game; that we find out what these obstinate elements really are, that we learn how they came into being, and wherefore their number, their properties, and their mutual relations are such as we find them? We shall then know, *d priori*, what we have now to find out by special experiment; we shall foresee the results of every conceivable reaction, and our theories will legitimate themselves by the power of prediction. To attain such knowledge seems to me the grand task of the chemistry of the coming age.

If you think I have given too free rein to the "scientific imagination" you will, I hope, forgive me as one who at least does not despair of the future of our science.

* If we accept the hypothesis that the elementary substances are composed of atoms, we cannot avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity."—Helmholtz, Faraday Lecture, 1881.

ON THE PHOSPHORESCENCE OF ALUMINA.

By M. EDMOND BECQUEREL.

M. de Boisbaudran has forwarded to the author two samples of alumina which he had prepared from alminium chloride, and one of which had been ignited by him at a high temperature. This specimen, which in his hands—when excited by electric discharges in a very high vacuum—emitted merely a green light, without a trace of red, gave in the hands of M. Becquerel, in a phosphoroscope under the action of the light of the voltaic arc, an emission of *red* phosphorescent light. This result agrees with all those previously obtained by M. Becquerel with specimens of alumina as pure as possible. As the author intimated, in a recent memoir, the methods of excitation not being the same, it is not surprising that the luminous emission, though from one and the same matter, should be different. In a phosphoroscope we excite the substances directly by means of the rays which are projected upon their surface, and which are comprised between the extreme refrangibilities furnished by the exciting source. In these conditions M. Becquerel has shown that there are two active parts in the solar spectrum giving to alumina, or to the ruby, or to chromated alumina the power of *red* phosphorescence. One portion begins abruptly about D and extends almost to F; the other, less active than the former, extends up to H.

In tubes containing air highly rarefied the electric discharges are scarcely visible, and rays are found comprised between the refrangibilities A and H. It is therefore very probable that the exciting rays are for the greatest part of an extreme refrangibility,—that is to say, of a very small wave-length, rays which are absorbed by a very slight gaseous stratum. These rays excite the alumina differently from the less refrangible rays, and give, possibly, a phosphorescence of green rays of an extremely short duration, less than is necessary for producing an impression in the phosphoroscope. This hypothesis M. Becquerel hopes to verify experimentally.

But without any attempt to show the difference of the effects produced upon alumina by the two above-mentioned methods of experimentation, the author cites the fact that if, in a tube containing rubies, the vacuum is imperfect, they give scarcely a trace of light under the influence of the electric discharges, whilst if the vacuum is rendered

more perfect they become illuminated with a brilliant red light, as they always do in the phosphoroscope.

M. Becquerel has, moreover, demonstrated long ago that though the presence of chrome much intensifies the power of alumina to emit red phosphorescent rays in the phosphoroscope, yet alumina as pure as possible, if similarly treated, gives an emission of rays of the same colour, though of less intensity. It may even be possible that chrome imparts to alumina a different absorptive power for the exciting rays of light, and thus augments its phosphorescent power. There may then be produced an action of the same kind as that possessed by colouring-matters in virtue of which they modify the absorbent power of bodies chemically susceptible to light, and render them sensitive to the action of rays which do not act upon them without this admixture.

The complication of effects observed when employing the discharges in tubes of very rarefied gases, as well as the differences in the duration of the rays emitted by phosphorescence, seem likely to explain the differences presented by one and the same specimen of alumina excited in these tubes, or submitted to the action of the sun or of the voltaic light in a phosphoroscope.—*Comptes Rendus* (civ., p. 334).

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JANUARY 31ST, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, February 7th, 1887.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from January 1st to January 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

At the beginning of this year, as at the end of last year, the river was in a swollen and turbid state from the influx of snow-water, carrying with it much clayey matter; and as a result, during the first fortnight of January, as during the last fortnight of December, several samples of the water furnished by three of the Companies drawing their supply from the Thames were, as set forth on Table II., found to be slightly turbid. The latest samples recorded as "very slightly turbid" were taken on the 14th and 15th of the month, one out of the seven taken on each day, since when the water delivered by all the Companies alike has been uniformly bright and well filtered. Throughout the month, the water, except that supplied by the New River Company, was found, when examined in bulk, to present a slightly brownish tint of colour. The proportion of organic matter present, though not high for the season of the year, was appreciably above that of the previous month's supply, the mean amount of organic carbon in the Thames-derived water-supply being 0·199 part in 100,000 parts of the water, corresponding to between three and four-tenths of a grain of organic matter per gallon.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

ZINC EISEN.

By H. N. WARREN, Research Analyst.

THE use of this compound, although greatly limited, an in itself being useless as an alloy, on account of its great brittleness, however promises to be of considerable value in pyrotechny, on account of the brilliant and at the same time peculiar light attending its combustion when admixed with other pyrotechnic ingredients; it is also possessed of theoretical interest, since it involves a ready and at the same time simple method of producing an alloy existing between a somewhat highly volatile metal zinc and a non-volatile metal iron; it also furnishes by far the best method of producing finely-divided zinc, in cases where the presence of iron is not objectionable. The best method of preparing the alloy is as follows:—From 1 to 2 lbs. of zinc are raised to the melting-point in a clay crucible, and from 3 to 3½ ozs. of anhydrous sodio-ferrous chloride are thrown on the surface of the molten zinc, the top of the crucible being immediately covered in order to exclude air. A violent reaction immediately takes place, and terminating in the above alloy, in admixture with zinc chloride according to the following equation:—$Zn + FeCl_2 = ZnCl_2 + Fe$. The excess of zinc alloying itself with the reduced iron, forming a highly brittle substance possessing a full metallic lustre, and admiting of being pulverised with the utmost ease. The alloy when performed in this manner seldom varies from 11 to 13 per cent.

THE QUANTITATIVE DETERMINATION OF BORIC ACID.

By TH. ROSENBLADT.

FOR the determination of free boric acid in substances soluble in water or in acids, or if combined with an alkali or with magnesia, the methods indicated by A. Stromeyer and C. Marignac are found sufficient. The case is different when boric acid must be determined in the course of a complicated analysis, as, for instance, in the silicates. The known methods are then either quite inapplicable or give untrustworthy results.

In the *Zeitschrift* (xiv., p. 360) Ditte proposed a method in which calcium borate is separated out in a form insoluble in water. The author has made use of this process in the analysis of tourmalines, but no concordant results could be obtained.

Upon the whole, direct determinations of boric acid belong to the most complicated operations of analytical chemistry, whence it is usually determined by the inaccurate method of difference.

The characteristic green colouration of a spirit-flame is still commonly employed for the detection of boric acid. This colouration of the flame depends on the dissociation of boric ethyl ether, which boils at 120°. On one occasion the author found this method unsuccessful, on account of the simultaneous presence of copper chloride. He substituted methylic alcohol, and obtained the corresponding boric methyl ether, distinguished by its extra-

ordinary volatility, as it boils at 65°. The reaction came up very distinctly.

The experiment was then modified as follows: the substance was put in a short, wide test-tube, with a little concentrated sulphuric acid; when it was cold methylic alcohol was gradually added, and the tube was closed with a caoutchouc stopper having two perforations. The two apertures receive two glass tubes, one bent at right angles and reaching almost to the bottom of the tube, and the other, ending below the stopper, about 5 c.m. in length and drawn out at the exterior end to 1 m.m. Hydrogen gas (or coal-gas) was passed through the apparatus, and a light was applied to the gas as it escaped. A fine green flame was at once obtained, which, on examination with the spectroscope, shows the characteristic spectrum of boric acid.

This method renders it possible to detect boric acid even in presence of other substances which give a green colour to flame, as with this arrangement a green colouration is produced by boric acid only.

For the quantitative determination of boric acid the author constructed the following apparatus: he took a wide-mouthed Erlenmeyer flask, perfectly dry and holding 100 c.c., closed it with a cork having two perforations; through one of these passed a tube funnel, fitted with a cock and reaching down almost to the bottom of the flask; through the other passed one limb of a condensing-tube: the second limb of the condensing-tube opened into another dry Erlenmeyer flask, which was closed in like manner with a doubly-perforated cork. Through the second perforation of this cork passed one limb of a tube bent twice at right angles, whose second limb was dilated in a globular form and led into a small flask. This last flask contained a little water and ammonium carbonate. The entire apparatus was closed air tight.

The substance under examination, finely powdered and weighed out, is put into the first flask and moistened with methylic alcohol; the flask is then closed with the cork; the funnel tube (with the cock shut) is then filled with sulphuric acid (sp. gr. 1·84), taking twice as much acid as the weight of the substance. After proper arrangements have been made for good refrigeration the sulphuric acid is gradually let drop into the flask by partially opening the cock, and afterwards 10 c.c. of methylic alcohol are gradually introduced in the same manner. The flask is then set in a capacious beaker filled with water, which is heated as long as methylic alcohol distils over; 5 c.c. more methylic alcohol are then added in the same manner through the funnel tube, and the distillation is renewed.

This process is several times repeated, and in general 40 to 50 c.c. of methylic alcohol suffice to volatilise 0·3 grm. boric acid. After the distillation is complete the receiver is taken away, the contents of the small flask added to the distillate; the globe tube is rinsed out, and to the entire liquid are added 10 c.c. of a solution of ammonium carbonate (1 : 10). During the distillation magnesia—about three times as much as the probable amount of boric acid to be determined—is put into a platinum capsule holding 40 to 60 c.c., the capsule is covered with a lid and strongly ignited, and when cold the tare is determined along with the magnesia. As magnesia is very hygroscopic the weighing must be performed very carefully and expeditiously.

The weighed magnesia is then moistened in the capsule with ammonium carbonate, the distillate is introduced into the capsule and carefully evaporated down upon a sheet of asbestos, carefully avoiding loss; the residue is ignited and again weighed.

The increase of weight in the capsule and its contents gives the weight of the boric acid present in the sample.

Compounds insoluble in acids, such as silicates, are opened up with potassium-sodium carbonate before distillation; the melt is then carefully pulverised so as to avoid all loss, and is then distilled, as above directed, with sulphuric acid and methylic alcohol. To remove any particles adhering to the crucible, the author rinses it out with the sulphuric acid about to be used.

Substances containing fluorine, such as tourmalines, are strongly ignited before being opened up; the loss is noted and taken into account in the analysis.

It is scarcely necessary to remark that the sample before being opened up should be in the finest state of division.

In the analysis of minerals, &c., containing chlorine, silver sulphate must be introduced into the Erlenmeyer flask to prevent the evolution of hydrochloric acid.

In these operations only such methylic alcohol must be used as, if heated with sulphuric acid in the water-bath, neither blackens nor evolves sulphurous acid.—*Zeitschrift f. Anal. Chemie* (vol. xxvi., part 1, p. 18).

INVESTIGATION OF THE ATOMIC WEIGHT OF TUNGSTEN.

By JOHN WADDELL, Ph.D. (Heidelberg), D.Sc. (Edin.).

OWING to theoretical considerations which need not be here detailed, I was led to doubt the accuracy of the atomic weight of tungsten which has usually been accepted as correct, and an investigation of the literature of the subject did not satisfy me that sufficient care had been taken to ensure the purity of the materials employed. Molybdenum and silica especially are impurities likely to occur, and little evidence was afforded that they were absent in the compounds from which the atomic weight of tungsten was estimated.

The method of purifying by re-crystallisation, though the one almost universally adopted, seemed open to objection, and I decided to try the method of fractional precipitation. In order to carry out this process it was necessary to prepare an alkaline tungstate, and it was advisable to have it as pure as possible before proceeding with the precipitation. It was designed to get a series of precipitates of such a character that, if pure from admixture, tungstic acid could be readily obtained, by the reduction of which to metallic tungsten the data necessary for atomic-weight determination are afforded. Similarity of composition in the precipitates was to be taken as a guarantee of purity; for it was unlikely that impurities present would be thrown down in the same proportion in all the fractionations. If a difference occurred in the precipitates, those at the extremes should be most unlike, while those near the middle should have practically the same composition, and might fairly be accepted as pure. This paper is to be devoted chiefly to a description of how the above plan was carried out, with an account of some of the difficulties encountered and the precautions adopted, together with the results arrived at by the investigation.

Some preliminary experiments were made with scheelite, in order to test methods of separation of silicon and molybdenum, both of which were present in the mineral. Scheelite is essentially calcium tungstate; the sample I worked with also contained iron in some form. The mineral was disintegrated by boiling with aqua regia, and the soluble chlorides filtered off from the portion insoluble in acid. This precipitate was bright yellow in colour, and along with tungstic acid contained considerable silica and a little molybdic acid. Attention was first directed to methods of separating silica, two methods being tried. The first was fusion of the mixture of silica and tungstic acid with potassium hydrogen sulphate, by which operation soluble tungstate (with molybdate when molybdic acid is present) is produced, the silica being unattacked. Details of the operation are given in the Appendix. The solution of tungstate and sulphate having been obtained free from silica, the next step was to precipitate the tungsten in some form.

Theoretically it is possible to precipitate tungstic acid

from a mixture of alkaline tungstate and sulphate by heating with sulphuric acid. In this process care must be taken to regulate the temperature properly, for if too low the tungstic acid does not separate out, and if too high the mass fuses and reproduces the original tungstate. This method, which may be used with small quantities, though even in such cases probably not very satisfactory, did not seem capable of application on the large scale. A method of separation common enough in quantitative analysis is to use mercurous nitrate as a precipitant. Mercurous tungstate is thrown down, and from that precipitate tungstic acid can be obtained either by sublimation of the mercury or by extraction of the latter with aqua regia. I thought that this method might prove of use for fractional precipitation, and proceeded to test it. I found that the mercurous tungstate is difficult to filter, the precipitate having a tendency to run through the paper. The same difficulty presents itself in filtering the tungstic acid obtained by treatment of the mercurous tungstate with aqua regia. These obstacles were not insurmountable, however, for if water containing mercurous nitrate be used for washing the tungstate the filtration can be carried on successfully. In the same way very dilute hydrochloric acid, if used to wash the precipitate of tungstic acid, makes the operation of filtering quite easy.

A much more serious difficulty was presented by the sparing solubility of mercurous salts. It was only possible to make a dilute solution of mercurous nitrate, and even this dilute solution seemed to precipitate sulphate as well as tungstate. I found that mercurous nitrate continued to give a precipitate, though excess of mercury seemed to be present, a test portion of the liquid giving with hydrochloric acid a precipitate of mercurous chloride, as also a precipitate with sulphuretted hydrogen. The use of large quantities of liquid being disadvantageous, this method of separation was abandoned. The second method of separation of silica and tungstic acid tried was digestion with ammonia. The best method for carrying out the operation is described in the Appendix. As a result of my work some ammonium tungstate was obtained, but the extraction of the tungstic acid was not complete. Later experience indicated slight improvements in detail, such as would make the extraction more perfect, but in the meantime a material had been obtained almost free from silica.

Of the preliminary work it only remains to describe the process employed for eliminating the molybdenum. Some of the ammonium tungstate above described, which contained part at least of the molybdenum originally in the scheelite, was changed into the sodium salt by fusion with sodium carbonate. To a solution of tungstate thus obtained enough tartaric acid was added to prevent precipitation of tungstic acid by acidification with hydrochloric acid. A stream of sulphuretted hydrogen, passed for several hours formed a slight precipitate, which gave the borax and microcosmic beads characteristic of molybdenum. The filtrate was evaporated to dryness in a platinum basin, and the mass heated till it began to char. Potassium nitrate was added in small portions till the carbon was all oxidised and a white mass obtained, mainly tungstate, but containing chloride and carbonate as well. These impurities presented no special disadvantages, but the process of evaporation of the tartrate and subsequent ignition with nitre was troublesome.

The process of elimination of silicon and molybdenum seemed, therefore, likely to prove an easy task. I hoped to avoid the difficulty by using as starting-point a material containing neither of these impurities. With this view I procured commercial tungsten, a dark grey powder containing 94 to 98 per cent of the metal. I was assured by the manufacturer that molybdenum was absent. At the outset I was met by the difficulty of getting the material into a workable form. So slowly is it attacked by acids that my attempts to oxidise it by aqua regia were very imperfectly successful. Better results were obtained by throwing a mixture of the metal with nitre into a red-hot crucible. The crucible itself was attacked, however, and a third method was tested. On the small scale the results were good, and considerable attention was devoted to the determination of the most favourable conditions. The method consisted in igniting a mixture of potassium chlorate, sugar, and metal. Evidently what was desired was a high temperature and a large quantity of available oxygen. The proportions found most suitable were—chlorate 9 parts, sugar 3 parts, tungsten 5 parts. The oxidation was in this way very rapid, but from the potassium tungstate thus produced it was almost impossible to get a fair yield of tungstic acid, owing to the presence of the large quantity of other salts. A much more satisfactory mode of oxidation was by the direct action of air at a high temperature. The commercial tungsten was placed in a porcelain tube in a Fletcher's furnace, and heated to redness in a current of air. Fumes of sulphurous acid were evolved, and were absorbed by a caustic soda solution. In this solution molybdic acid was afterwards found, though only in very small quantity. At the end of six hours the tungsten was oxidised to a greenish mass. The colour was due to imperfect oxidation. When the roasting was continued for about thirty hours a yellow powder was obtained, there being very little, if any, unoxidised tungsten. The green substance, however, was quite suitable for further manipulation, as it contained only about 5 per cent of unoxidised material, and this was readily separated.

A preliminary experiment showed that it would be impossible to extract the tungstic acid from the green powder by boiling with solution of caustic soda. I therefore fused it with half its weight of carbonate of soda, digested the fused mass with water, and filtered off from the unoxidised residue. The filtrate was evaporated in a large silver basin with addition of ammonium carbonate, the precipitate formed filtered off, and the filtrate evaporated down as before, the process being repeated till the carbonate produced no more precipitate. The total precipitate was very small, and proved to be chiefly, if not entirely, alumina. During the evaporation a thin copper-coloured film appeared on the silver basin. This film was soluble in hydrochloric acid, giving a blue solution which became decolourised on exposure to the air or addition of a drop of nitric acid. The film was evidently some compound of tungsten, and I believe that titanium salts give similar deposits in platinum vessels.

The clear solution of tungstate, which naturally contained carbonate, was evaporated to small bulk, and thus crystals were obtained. As, however, the mother-liquor was quite colourless and clear, I continued the evaporation to dryness. In this way I prepared nearly 3 kilos. of mixed tungstate and carbonate. In a trial portion of this substance I proved the presence of an appreciable, though small, quantity of molybdenum.

After considerable investigation I was not able to find a more convenient method for separating molybdenum and tungsten than the one already given, which is recommended by Rose. I found, however, that the subsequent elimination of tartaric acid was unnecessary for my purpose. I discovered that, while the presence of no very large quantity of this acid prevents the precipitation of tungstic acid by *cautious* addition of a *little* hydrochloric acid, a considerable excess of the latter, even if slowly added, gives a precipitate. This precipitate can be redissolved by tartaric acid in *large* excess *only*, but, once re-dissolved, *much* hydrochloric acid can be added before precipitation again occurs.

A solution of 300 grms. of tunstate was added to a solution of 150 grms. of tartaric acid, and the molybdenum separated as above described. The filtrate had a blue colour, evidently due to some reduction of the tungstate; but a current of air passed for several hours through the solution decolourised the liquid, which was then ready for fractional precipitation.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Special General Meeting, February 26, 1887.

Prof. W. G. Adams, Vice-President, in the Chair.

The Resolution passed at the meeting on February 12th, providing greater facilities to persons living abroad for qualifying for membership of the Society was unanimously confirmed. The meeting was then resolved into an ordinary one, at which Prof. W. Stroud and Mr. G. S. Gulbenkian were elected Members of the Society.

Mr. James Swinburne read a "*Note on Prof. Carey Foster's Method of Measuring the Mutual Induction of Two Coils.*"

The author described an apparatus devised last summer for measuring mutual induction by a null method, thus dispensing with a ballistic galvanometer. The induction in the secondary coil is balanced by an opposite effect produced by a variable known fraction of the primary current passing through one wire of a double-wound coil of known mutual induction, the other wire of which is joined in series with the secondary coil and galvanometer.

In a preliminary trial, using an ordinary reflecting galvanometer, it was found that, instead of no deflection being observed, two kicks in opposite directions occurred when there was iron in the circuit. A new galvanometer with heavy needle is now being constructed to overcome this difficulty.

A null method of finding the ohm, by means of a differentially-wound heavy needle galvanometer, is suggested in the latter part of the note.

Prof. Ayrton pointed out that Prof. Foster's method does not require readings on a ballistic galvanometer, and mentioned that in practice it is greatly superior to those given in Maxwell and the ordinary text-books. The chief drawback is the necessity of having large condensers of accurately known capacity where large coefficients are concerned. A large number of experiments have been carried out at the Central Institution, by Mr. Sumpner, with very satisfactory results.

Prof. Adams concurred in Prof. Ayrton's statement regarding the difficulties in using Maxwell's methods in practice, and expressed his satisfaction with the great simplicity of Prof. Foster's method.

"*On the Determination of Coefficients of Mutual Induction by means of the Ballistic Galvanometer and Earth Inductor.*" By R. H. M. Bosanquet, M.A.

The methods described depend on two measurements of the throws of a ballistic galvanometer:—1st, that produced by the sudden rotation of a coil (the constants of which are accurately known) through 180° about a vertical axis; and 2nd, that produced by the mutual induction to be measured when a current of known strength is started in the primary circuit. The earth induction coil is permanently joined in series with the ballistic galvanometer and secondary coil, and the primary current measured by an absolute tangent galvanometer of the Helmholtz pattern.

If Q_0 and Q be the quantities of electricity which pass through the ballistic galvanometer in the two experiments, then—

$$Q_0 = \frac{2 N A H}{R},$$

where N A is the effective area of the inductor, and—

$$Q = \frac{M C}{R},$$

where $C = G H \tan \theta$. Hence—

$$\frac{Q}{Q_0} = \frac{M G \tan \theta}{2 N A} = \frac{\alpha}{\beta},$$

where α and β are the throws of the ballistic galvanometer. From the above we get—

$$M = \frac{\alpha}{\beta} \frac{2 N A}{G \tan \theta}.$$

A modification to be used when M or R is very large is also described.

Numerical results obtained are given, from which it is inferred that Maxwell's formulæ for calculating the mutual induction of two circular coils cannot be applied where the distance between their central planes is at all comparable with their radii.

Experiments on an A gramme dynamo gave very irregular results when the currents were small, owing to the subpermanent magnetism of the machine.

Further uses of the method are suggested, such as the absolute determination of capacity and resistance.

Remarks on the subject were made by Prof. Carey Foster and Mr. Swinburne, and Prof. Ayrton replied to Mr. Swinburne's contention that Prof. Foster's method was not independent of observations of a ballistic galvanometer (since capacities are determined by their means), by pointing out that where accurate standards exist it is quite legitimate to base other absolute measurements on them.

Prof. Reinold then read an abstract of a paper on "*The Continuous Transition from the Liquid to the Gaseous State of Matter at all Temperatures.*" By Prof. W. Ramsay and Dr. Sydney Young.

The authors find the relation between pressure and temperature of gases and liquids at constant volume expressible by $p = b t - a$, where b and a are constants, and therefore conclude that the isochors (*i. e.*, curves connecting p and t for constant volume) are straight lines. At temperatures below the critical point the isotherm, during passage from the gaseous to the liquid state, is a serpentine curve intersected by the horizontal line of vapour-pressure corresponding with that temperature, the two areas between the curve and straight line being equal. By experiment and extrapolation the authors find the loci of the apices of the serpentine curves, corresponding with different temperatures, to intersect at the critical point.

The above results are proved for ether and carbonic dioxide, and the authors believe them to be true for all stable substances.

Prof. Rücker remarked that, if similar relations held for liquids and solids, the triple point of intersection would be of immense interest.

Prof. Perry, whilst regarding the results as of vast importance, thought the curves and calculations should be very carefully discussed before being finally accepted.

NOTICES OF BOOKS.

Year Book of Pharmacy: comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry contributed to British and Foreign Journals, from July 1, 1885, to June 30, 1885; with the Transactions of the British Pharmaceutical Conference at the Twenty-third Annual Meeting, held at Birmingham, September, 1886. London: J. and A. Churchill.

The abstracts given in this goodly volume are arranged under the two heads of Chemistry and Materia Medica with Pharmacy. But the editors nevertheless find it difficult to draw a hard and fast boundary.

Thus we find in the second division an account of alkanet root and of its tinctorial principle anchusine, the whole being prefaced by the remark that the plant is "not used in pharmacy." Quillaja bark, once exclusively used in the tinctorial arts, has now found its way into medical use, on which account its place in the second section is perfectly

justifiable. Harmeline and its derivatives ought surely to have figured under the head of chemistry, the more as there is no mention of finding any pharmaceutical applications.

A paragraph by Du Moulin, quoted from the *Journal de Pharmacie*, confirms the opinion now becoming prevalent that copper can scarcely rank as a poison.

Salkowski's researches on the poisonous constituent of the mussel are chiefly quoted from *Chem. Centralblatt.* The poisonous specimens are said to yield a green alcoholic extract, while the extract of wholesome specimens is colourless. Will and Leymann's paper on the constituents of cochineal might have found a more appropriate place under chemistry.

The President, in his address, very appropriately asks —"Have we taken any steps to examine new and hitherto little-known drugs and to supply the most suitable formulæ for the preparation of the same before they get into the hands of the "mystery mongers" by whom they are brought to the notice of the medical profession?" He considers that the "proprietary preparations, for the most part 'factory made,' thrust upon the medical profession and unblushingly advertised, are sapping the foundations of true pharmacy and at the same time depriving the pharmacist of the legitimate practice of his calling." With the President's protest against this great and growing evil we can fully sympathise, and we hope that the Pharmaceutical Conference may devise some plan adequate to the occasion. But when Mr. Atkins speaks, apparently without disfavour, as far as general principles are concerned, of the poison Bill introduced by Lord Carlingford our sentiments are very different. We cannot protest too strongly, alike in the name of pure science and of the chemical arts, against all attempts to fetter the sale of the most indispensable reagents with red-tape formalities because, forsooth, they disagree with anyone who is foolish enough to swallow them. "Poison Bills" are something more than farcical in a country where professional criminals and members of dangerous societies can openly buy revolvers and ammunition.

CORRESPONDENCE.

TRANSPARENCY OF MOLTEN IRON.

To the Editor of the Chemical News.

SIR,—Some days ago I was present when a casting was made involving the pouring of several tons of molten cast-iron. The stream was very regular, and resembled a great waterfall. It was possible to see objects through the molten metal, which appeared to be of a yellowish colour, but tolerably transparent. Two gentlemen who were present were also convinced of the transparency of the metal. May I ask, through your columns, the opinion of those who have frequent opportunities of being present during the operation of casting, regarding this seeming transparency?—I am, &c.,

WILLIAM RAMSAY.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 4, January 24, 1887.

Direct Fixation of the Gaseous Nitrogen of the Atmosphere by Arable Soils.—M. Berthelot.—According to the author's experiments arable soil continually fixes free atmospheric nitrogen, even without any vegetation properly so-called. This gain cannot be ascribed to atmospheric supplies of nitrogenous compounds, whether gaseous or dissolved in rain-water. In the experiments where the rain water flowed away outside after having traversed the soil, the rain removed from the soil, in the shape of nitrates alone, more nitrogen than it had brought in the shape of ammonia and nitric acid taken together. Nevertheless the fixation of nitrogen was more considerable in earth exposed to the rain than in such as was under cover, doubtless by reason of the greater activity of the organisms which fix nitrogen by the circulation of air and water.

Action of Carbon Tetrachloride upon Chlorochromic Acid and the Phosphates of Sesquioxide.—H. Quantin.—The author has previously shown that carbon oxide splits up chlorochromic acid into green chromium sesquioxide and a sesquioxide of the same metal, and that an excess of chlorine determines its entire transformation into the violet chloride. It is the same with carbon chloride, the products being chromium sesquichloride, chlorocarbonic oxide, and free chlorine. Another interesting reaction occurs when carbon tetrachloride reacts upon oxy-salts. As an instance the author takes neutral ferric phosphate. If a current of the tetrachloride is passed over a boat containing this phosphate, heated below the decomposition-point of the tetrachloride, there are produced violet vapours. If these are passed through a column of potassium chloride heated to about 200° the ferric chloride is stopped in its passage, and in the cold parts of the tube following after the column of potassium chloride there is deposited a yellowish crystalline body of an irritating odour, which eagerly absorbs moisture. The excess of tetrachloride carries away a part of this body. The crystalline matter condensed in the tube is phosphorus perchloride.

Preparation, Properties, and Constitution of Inosite.—M. Maquenne.—Pure inosite is not attacked at its boiling-point by dilute acids and alkalies. It does not reduce cupropotassic liquor. It does not combine with sodium bisulphite, and is not attacked by sodium amalgam.

Separation of Mono- and Di-isobutylamine by Means of Oxalic Ether.—H. Malbot.—The general procedure recommended by MM. Duvillier and Busine enables us to obtain calcium mono- and di-isobutyloxamates which have not previously been produced. These two compounds are easily separated by crystallisation. By means of these two pure bodies we may obtain pure mono- and di-isobutylamine.

Justus Liebig's Annalen der Chemie, Vol. ccxxxvii., Part 1.

Benzo-quinoncarbonic Acids.—J. U. Nef.—The author studies the conversion of durol into durolquinone; its transformation into dinitrodurylic acid; the conversion of dinitrodurylic acid into durylic quinone and the conversion of dinitrodurylic acid into quinone tetracarbonic ethylester.

Proportion of Carbonic Acid in the Atmosphere.—R. Blochmann.—The author first reviews the earlier researches which, as he shows, gave excessive results. Up to 1870 it was supposed that air over continents contained, as a mean, 0·0004 volume of carbonic acid, or about one-fourth more than the true amount. The determinations of the earlier observers gradually approximated more and more closely to the truth. Thus, in 1827 Saussure found 5·1 volumes of carbonic acid in 10,000 vols. of air; in 1828 4·4; in 1829, 4·0; and 1830, 3·7. In like manner Schulze found, in his determinations from 1863 to 1864, a mean of 3·64 volumes per 10,000, whilst from 1868 to 1871 he obtained only 2·92. This fact proves that there are difficulties in the way of an exact quantitative determination of carbonic acid in the air, which the observer gradually overcomes

in virtue of experience and of increasing manipulative skill. The cause of the difficulties lies in the very nature of the problem. It is required to determine a magnitude which is only 0·0003 of the substance under examination. An error of only one-millionth as compared with the latter affects the value sought by one per cent. In every analytical operation a knowledge of the possible errors of observation is a necessary condition for the certain appreciation of the value of the result; a precise knowledge of the limits of error is here absolutely essential. In case of the determination of a relative magnitude, *e.g.* the difference of the carbonic acid by day and by night, a knowledge of the accidental errors is sufficient, as the constant errors disappear in the difference. But in ascertaining the mean proportion of carbonic acid in the air, *i.e.* an absolute magnitude, the constant error comes to the front. Synthetic attempts to check the sum of all errors of observation seem to have been made only twice, and these check experiments seem to have involved, in addition to the error of observation in the analysis, a further and opposite and almost equal error in the synthesis of the gaseous mixture. All the chemical methods used for the determination of carbonic acid depend on its absorption by alkalies or alkaline earths. Either they take into consideration the gaseous volume which has disappeared, or they determine directly the increase of weight of the absorbing agent, or they separate the carbonic acid as barium carbonate, or they ascertain by titration the reduced alkalinity of the absorptive liquid, or they re-liberate the carbonic acid after combination with an absorbent and measure its volume. All these methods resolve themselves into two groups, according as the volume of air operated on is bounded by the size of the apparatus or obtained by means of an aspirator. The former class embraces volumetric, gravimetric, and titrimetric processes. The volumetric method was first brought into use by A. v. Humboldt and was subsequently developed by Lewy, de Luna, Frankland, and Macagno. Even by the most exact eudiometric methods the carbonic acid of the atmosphere cannot be determined with certainty, and the conclusions which Lewy, Frankland, and Macagno drew from their researches cannot, therefore, be regarded as proven. Th. de Saussure is the only chemist who attempted to determine gravimetrically the acid in limited volume of air. His method was inconvenient, as it involved the use of flasks holding from 30 to 45 litres, previously exhausted of air, and involved certain sources of error. Dalton was the first to calculate the carbonic acid from the consumed absorbent. In this manner he executed, as far back as 1802, the first approximately accurate determination of the carbonic acid of the air. His mehod was forgotten, until revived in 1858 by Max v. Pettenkofer, without knowledge of Dalton's investigations. The aspiration methods likewise include direct weighing of the aspiration apparatus and titrimetric and volumetric determinations. The results as now ascertained are:—The average carbonic acid of our atmosphere is 0·00030 by volume. 2. The proportion of carbonic acid of the air over land and sea is in general the same. Over land the air contains by day 0·2 to 0·3 per 10,000 volumes less than by night. Over the sea a corresponding difference has not been recognised. 3. The fluctuations in the quantity of carbonic acid are generally within 1-10,000th part, about from 2·5 to 3·5 volumes for 10,000 vols. of air. 4. The influences of vegetation, of processes of decay in the soil, of the augmented consumption of fuel in cities, &c., are perceptible only in the immediate neighbourhood of such processes. Only volcanic actions have a measurable effect upon the proportion of carbonic acid in the air for great distances. 5. During fogs and when the sky is overcast and a calm prevails there is more carbonic acid than when the heavens are clear and the air in motion. As regards rain no definite regularities have been traced. The carbonic acid is sometimes increased in wet weather, sometimes diminished, and sometimes unchanged. 6. In towns the proportion of carbonic acid in the air is not everywhere alike, but depends on local circumstance. The difference between the average proportion of carbonic acid in the air of populous cities and in that of the open country is but slight, and in the cities, in which it has been established by simultaneous determinations, it does not exceed 0·2 to 0·3 vol. in 10,0000 vols. of air. The author has made experiments on the further development of the Dalton-Pettenkofer method, which, if performed as described in the text-books, always gives too high results. It requires, however, the fewest accessories and the shortest time. Errors may possibly arise during titration from the circumstance that the air of the laboratory is generally much richer in carbonic acid than the air outside. As the liquid has to be closely observed during titration, it appears certain that a part of the air expired, containing 1 m.g. carbonic acid per c.c., comes in contact with the baryta water during titration. The author, therefore, modifies the apparatus as shown in the six accompanying figures. For these illustrations, with which the execution of the process is intimately connected, we must refer to the original.

On Pipitzahoic Acid.—R. Anschütz and J. W. Leather.—This compound is a monobasic acid, but it belongs not to the carbon acids, but to the phenoles. From its splendid golden-yellow colour, considered in combination with the circumstance that it consists merely of carbon, hydrogen, and oxygen, it appeared to be a quinone, as it has been experimentally proved. Its constitution is analogous to that of oxythymoquinone.

Journal de Pharmacie et de Chemie.
Series 5, Vol. xv., No. 2, January 15, 1887.

Two New Colours for Wines.—A. J. Ferreira de Silva.—An attempt has been lately made to introduce two new artificial colours to the Portuguese wine-growers. The one is a mixture of tropeoline O and methylene blue, and the other is rocceline red mixed with a violet and a blue matter, probably a rosaniline violet, and soluble indigo. Both these colours interfere with the preservation of wines, as they subside and carry down with them a part of the natural colour of the wines.

Vegetable Growths in Solution of Alkaloids.—L. Soubeiran.—The organisms in question are *Mucor mucedo*, *Aspergillus glaucus*, and *Penicillium glaucum*.

Certain Coloured Reactions of Titanic, Niobic, Tantalic, and Stannic Acids.—Lucien Lévy.—Already inserted.

Experimental Studies on the Action of Gases and Vapours Injurious to Health.—M. Lehmann.—The portion here inserted treats merely of hydrochloric acid and ammonia.

Studies on Digitaline.—Ph. Lafon.—The author does not admit that this poison accumulates in the animal economy. It seems to undergo a profound transformation in the circulation. Digitaline presents a relatively great resistance to physical and chemical agents, to ferments, and to putrefaction.

MISCELLANEOUS.

Messrs. Woodhouse and Rawson.—We have received from this firm the new edition of their illustrated catalogue and price list of electrical supplies, comprising incandescent lamps, electroliers, switches, safety fuses, electric bells, &c., &c. They inform us they make a point of keeping a stock of all small articles required by electrical engineers, a convenience which will be duly appreciated by those who have often lost much time waiting for the delivery of some article of comparatively small importance.

Working Studentships.—We are requested to announce that the Lords of the Committee of Council on Education have decided to make arrangements for the admission of a limited number of persons employed in industries in which Art is more or less concerned, to study in the South Kensington Museum, Library, and Schools, without the payment of any fees, for periods of from two to nine months, according to circumstances. Detailed rules with regard to these Working Studentships will be sent on application to the Department. Briefly, the conditions may be stated to be that the designer or workman for whom admission is sought shall show that he has sufficient power, in drawing and sketching, to be able to profit by the opportunities afforded; that he is actually engaged in some Art Industry, and that the proprietors of the Works in which he is engaged undertake to maintain him while he is studying at South Kensington. When admitted the working student will be set, under direction, to study in the Museum and Art Library from examples relating to the industry in which he is employed, and he will also receive instruction in drawing and designing in the Art School, suited, as far as may be, to his special case. This step has been taken with a view to render the Museum of more special and direct use to the country, and it is trusted that the valuable collection of examples of Applied Art which has now been brought together may thus be more fully appreciated and taken advantage of by the directors of industry in the country.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sulphate of Ammonia.—Is any book published that treats specially on the manufacture of sulphate of ammonia; and if so, where can it be obtained?—H. W.

Westphal Balance.—I believe a description of the Westphal Balance appeared in the Chemical News some years ago. Can any of the readers refer the writer to it?—Chemist.

MEETINGS FOR THE WEEK.

Monday, 7th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Building Materials," by W. Y. Dent, F.C.S.
—— Society of Chemical Industry, 8. "M. Hernick's System of Electrolytic Bleaching," by Messrs. Cross and Bevan. "Castner's Sodium Process," by J. Mactear. "A New Method of Elevating Liquids, specially applicable to Acids," by the same.
—— Royal Institution, 5. General Monthly Meeting.

Tuesday, 8th.—Institution of Civil Engineers, 8.
—— Medical, 8.30. (Anniversary).
—— Photographic, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.

Wednesday, 9th.—Society of Arts, 8. "Railway Brakes," by William P. Marshall.
—— Geological, 8.
—— Pharmaceutical, 8.
—— Microscopical, 8.

Thursday, 10th.—Royal, 4 30.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— Telegraph Engineers, 8.
—— Royal Institution, 3. "The Critics of the Age of Anne," by Edmund Gosse, M.A.

Friday, 11th.—Royal Institution, 9. "Society in the Fourth Century," by The Ven. Archdeacon Farrar, M.A., D D., F.R.S.
—— Astronomical, 8.
—— Quekett Club, 8.

Saturday, 12th.—Royal Institution, 3. "Sound," by the Right Hon. Lord Rayleigh.
—— Physical, 3.

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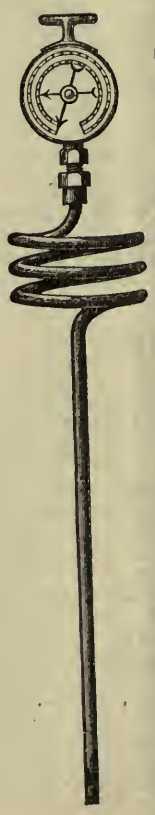

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THE CHEMICAL NEWS.

Vol. LV. No. 1424.

ON RADIANT MATTER SPECTROSCOPY :— EXAMINATION OF THE RESIDUAL GLOW.*

By WILLIAM CROOKES, F.R.S., V.P.C.S.

The duration of phosphorescence after cessation of the exciting cause is known to vary within wide limits of time, from several hours in the case of the phosphorescent sulphides to a minute fraction of a second with uranium glass and sulphate of quinine. In my examinations of the phosphorescent earths glowing under the excitement of the induction discharge in vacuo, I have found very great differences in the duration of the residual glow. Some earths continue to phosphoresce for an hour or more after the current is turned off, while others cease to give out light the moment the current stops. Having succeeded in splitting up yttria into several simpler forms of matter differing in basic power,† and always seeking for further evidence of the separate identity of these bodies, I noticed occasionally that the residual glow was of a somewhat different colour to that it exhibited while the current was passing, and also that the spectrum of this residual glow seemed to show, as far as the faint light enabled me to make out, that some of the lines were missing. This pointed to another difference between the yttrium components, and with a view to examine the question more closely I devised an instrument similar to Becquerel's phosphoroscope, but acting electrically instead of by means of direct light.

The instrument, shown in Fig. 1, A and B, consists of an opaque disk, *a b c*, 20 inches in diameter, and pierced with 12 openings near the edge as shown. By means of a multiplying wheel, *d*, and band, *e f*, the disk can be set in rapid rotation. At each revolution a stationary object behind one of the apertures is alternately exposed and hidden twelve times. A commutator, *g* (shown enlarged at Fig. 1, B), forms part of the axis of the disk. The commutator is formed of a hollow cylinder of brass round a solid wooden cylinder. The brass is cut into two halves by a saw cut running diagonally to and fro round it, so as to form on each half of the cylinder twelve deeply cut teeth interlocking, and insulated from those on the opposing half cylinder by an air space about two millims. across. Only one half, *h h h*, of the cylinder is used, the other, *i i i*, being idle; it might have been cut away altogether were it not for some little use that it is in saving the rubbing-spring, *j*, from too great friction when passing rapidly over the serrated edge. To a block beneath the commutator are attached two springs, one, *k*, rubbing permanently against the continuous base of the serrated hemicylinder, *h h*, and the other, *j*, rubbing over the points of the teeth of *h h*. By connecting these springs with the wires from a battery it will be seen that rotation of the commutator produces alternate makes and breaks in the current. The spring, *j*, rubbing against the teeth is made with a little adjustment sideways, so that it can be set to touch the points of the teeth only, when the breaks will be much longer than the makes, or it can be set to rub near the base of the teeth, when the current will remain on for a much longer time and the intervals of no current will be very short. By means of a screw, *l l*, attached to the spring any desired ratio between the makes and the breaks can be obtained. The intermittent primary current is then carried to an induction coil, *m*, the secondary current from which passes through the vacuum tube, *n*, containing the earth under examination. When the commutator, the coil-break, and the position of the vacuum tube are in proper adjustment, no light is seen when looked at from the front if the wheel is turned slowly (supposing a substance like yttria is being examined), as the current does not begin till the tube is obscured by an intercepting segment, and it ends before the earth comes into view. When, however, the wheel is turned more quickly, the residual phosphorescence lasts long enough to bridge over the brief interval of time elapsing between the cessation of the spark and the entry of the earth into the field of view, and the yttria is seen to glow with a faint light, which becomes brighter as the speed of the wheel increases.

To count the revolutions, a projecting stud, *o*, is fastened to the rotating axis, and a piece of quill, *p*, is attached to the fixed support, so that at every revolution a click is produced. With a chronograph watch it is easy in this way to tell the time, to a tenth of a second, occupied in ten revolutions of the wheel.

Under ordinary circumstances it is almost impossible to detect any phosphorescence in an earth until the vacuum is so high that the line spectrum of the residual gas begins to get faint; otherwise the feeble glow of the phosphorescence is drowned by the greater brightness of the glowing gas. In this phosphoroscope, however, the light of glowing gas does not last an appreciable time, whilst that from the phosphorescent earth endures long enough for it to be caught in the instrument. By this means, therefore, I have been able to see the phosphorescence of yttria, for example, when the barometer gauge was 5 or 6 millims. below the barometer.

When the earth under examination in the phosphoroscope is yttria free from samaria, and the residual emitted light is examined in the spectroscope, not all the bands appear at the same speed of rotation. At a slow speed the double greenish-blue band of Gβ (545) first comes into view, closely followed by the deep blue band of Gα (482). This is followed, on increasing the speed, by the bright citron band of Gδ (574), and at the highest speed the red band of Gζ (619) is with difficulty seen.

The following are measurements of the time of duration of the phosphorescences of the different constituents of yttrium. The wheel was first rotated slowly, until the first line visible in the spectroscope attached to the phosphoroscope appeared; the speed was counted, and it was then increased until the line next visible was seen. In this way the minimum speed of revolution necessary to bring each line into view was obtained, and from these data the duration of phosphorescence for each constituent of yttria was calculated. The time in the following table represents in decimals of a second the time elapsing between the cessation of the induction discharge and the visibility of the residual glow of the earth :—

At 0·0035	sec.	interval	the green and blue lines of Gβ and Gα begin to be visible.
At 0·0032	,,	,,	the citron line of Gδ begins to be visible.
At 0·00175	,,	,,	the deep red line of Gζ (647) is just visible.
At 0·00125	,,	,,	the line of Gδ is almost as bright as that of Gβ, and the red line of Gη is visible.
At 0·000875	,,	,,	the highest speed the instrument could be revolved with accuracy, all the whole of the lines usually seen in the yttria spectrum could be seen of nearly their usual brightness.

I have already recorded* that phosphate of yttria, when phosphoresced in vacuo, gives the green lines very strongly whilst the citron band is hazy and faint. The same tube of yttric phosphate was now examined in the phosphoroscope. The green lines of Gβ soon showed themselves on setting the wheel into rapid rotation, but I

* A Paper read before the Royal Society, Feb. 17, 1887.
† *Roy. Soc. Proc.*, vol. xl., pp. 502—509, June 10th, 1886.

* *Phil. Trans.*, Part 3, 1883, pp. 914-916.

was unable to detect the citron band of Gδ even at a very high speed.

The effect of calcium on the phosphorescence of yttria and samaria has been frequently referred to in my previous papers. It may save time if I summarise the results here. About 1 per cent of lime added to a badly phosphorescing body containing yttrium or samarium always causes it to phosphoresce well. It diminishes the sharpness of the citron line of Gδ but increases its brightness. It also renders the deep blue line of Gα extremely bright. The green lines of Gβ are diminished in brightness. Lime also brings out the phosphorescence of samarium, although by itself, or in the presence of a small quantity of yttrium, samarium scarcely phosphoresces at all.

In the phosphoroscope the action of lime on yttrium is seen to entirely alter the order of visibility of the constituents of yttrium. In a mixture of equal parts yttrium and calcium, the citron Gδ line is the first to be seen, then comes the Gα blue line, then the Gβ green line, and finally the Gη red line. This may, I think, be explained somewhat as follows:—Calcium sulphate has a long residual phosphorescence, whilst yttrium sulphate has a comparatively short residual phosphorescence. Now with

Fig. 1, A.

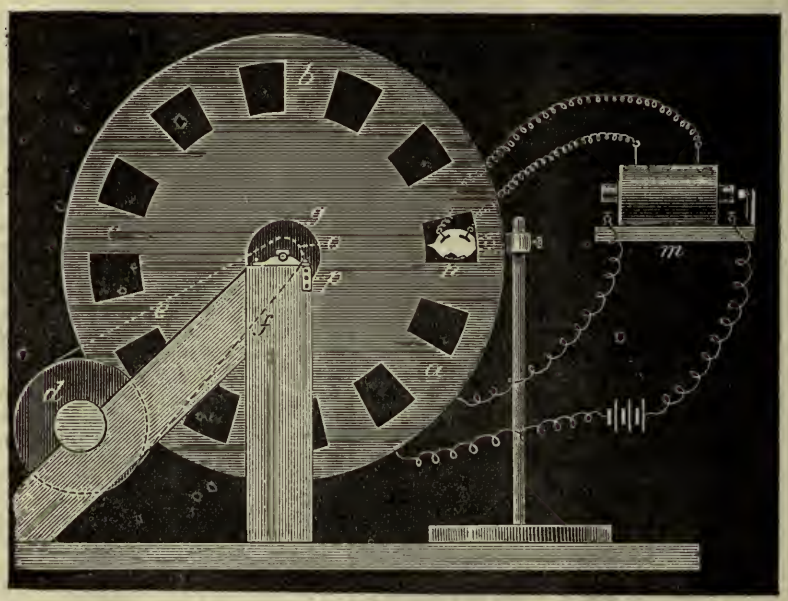
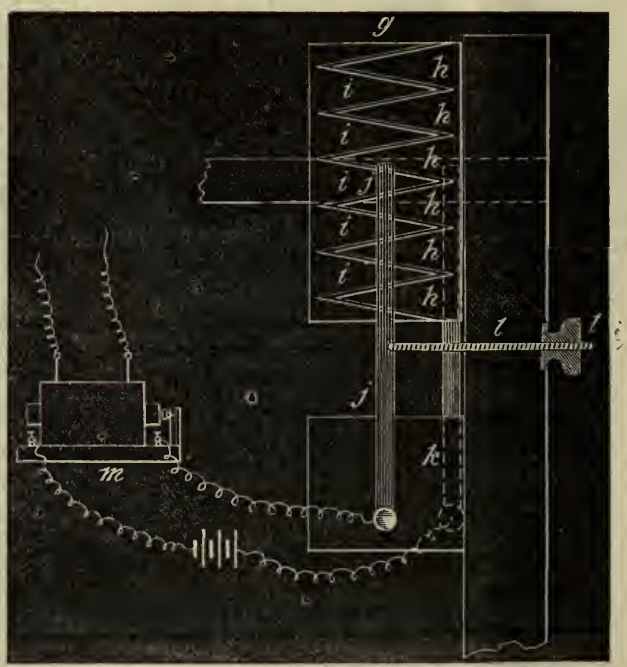


Fig. 2, B.



yttrium, although the green phosphorescence of Gβ lasts longest, it does not last nearly so long as that of calcium sulphate. The long residual vibrations of the calcium compound induce, in a mixture of calcium and yttrium, phosphorescence in those yttric molecules (Gδ) whose vibrations it can assist, in advance of those (Gβ) to which it is antagonistic; the line of Gδ therefore appears earlier in the phosphoroscope than that of Gβ, although were calcium not present the line of Gβ would appear first.

Experiments were now tried with definite mixtures of yttria and lime as ignited sulphates, to see where the special influence of lime on Gδ ceased.

Yttrium 97½%	Calcium 2½%	Order of appearance in the phosphoroscope.—Gβ, Gα, Gδ, and Gη. The citron line of Gδ is only to be seen at a high speed, and is then very faint.
Yttrium 95%	Calcium 5%	Order of appearance in the phosphoro scope. — Gα, Gβ, and Gδ (citron and blue) together, and lastly Gη (red). At a very high speed the green lines of Gβ become far more luminous than any other line.
Yttrium 90%	Calcium 10%	Order of appearance.—Gδ and Gα together, then Gβ, and lastly Gη.
Yttrium 80%	Calcium 20%	Order of appearance.—Gδ and Gα simultaneously. then Gβ, and lastly Gη. The residual phosphorescence lasts for 30 seconds after the current stops. The light of this residual glow is entirely that of Gδ. The line of Gβ comes into view at an interval of 0·0045 second. At 0·00175 second the line of Gη is just visible.
Yttrium 60%	Calcium 40%	Order of appearance.—Gδ and Gα together, then Gβ and Gη together.
,, 50	,, 50	
,, 40	,, 60	
Yttrium 30%	Calcium 70%	Order of appearance:—Gδ, Gα, Gβ.
,, 10	,, 90	
,, 5	,, 95	
Yttrium 1%	Calcium 99%	Order of appearance:—Gδ, Gα, the green lines of Gβ could not be seen in the phosphoroscope, they would probably be obliterated by the stronger green of the continuous spectrum given by the calcium.

The action of barium on yttrium was now tried. The following mixtures (as ignited sulphates) were made:—

Yttrium 95%	Barium 5%	In the phosphoroscope, the Gβ line appears earliest, but the blue Gα line is the next to be seen, whilst the red line of Gη is the latest in appearing. As the percentage of yttrium increases the blue line more and more overtakes the red and increases in brightness.
,, 90	,, 10	
,, 80	,, 20	
Yttrium 70%	Barium 30%	Spectrum similar to the above. As the percentage of yttrium increases the spectrum grows brighter. In the phosphoroscope the earliest line to appear is the Gβ green, then the Gη red, and next closely following it the Gα blue.
,, 60	,, 40	
,, 50	,, 50	
,, 40	,, 60	
,, 30	,, 70	
,, 25	,, 75	
Yttrium 20%	Barium 80%	In the radiant matter tube all these mixtures give similar spectra. The Gβ green is a little brighter and the Gδ citron is a little fainter than in the corresponding mixtures of yttrium and calcium, but the whole of the yttrium lines are seen. In the phosphoroscope the Gβ green is the first to appear, then the Gη red. The Gδ citron is not visible at any speed.
,, 15	,, 85	
,, 10	,, 90	
,, 5	,, 95	
Yttrium 1%	Barium 99%	Red line of Gη is much brighter; Gδ is very faint, and the green of Gβ is stronger. In the phosphoroscope the order of appearance is,—first the line of Gβ, then the red line of Gη.
Yttrium 0·5%	Barium 99·5%	Phosphoresces with difficulty, of a light blue colour, but turns brick-red in the focus of the pole. Spectrum very faint. Order of appearance to phosphoroscope:—Gβ first; the others too faint to be seen.

The next experiments were tried with strontium, to see what modification the addition of this body to yttrium would produce. The following mixtures of ignited sulphates were experimented with:—

Yttrium 95%	Strontium 5%	A very good yttrium spectrum. In the phosphoroscope the order of appearance is,—First the green of Gβ, then the Gα blue, lastly, the Gη red. No Gδ citron line could be seen.
Yttrium 80%	Strontium 20%	In the phosphoroscope the green of Gβ is very prominent at a low speed, standing out sharply against a black background. With a higher velocity the Gα and Gη lines come into view.
Yttrium 60%	Strontium 40%	The ordinary spectrum of this and the neighbouring mixtures is very rich in the citron line of Gδ, but I entirely fail to see a trace of this line in the phosphoroscope at any speed. The line of Gβ is the first to come, then the blue line of Gα.
,, 40%	,, 60%	

Yttrium 35%	Strontium 65%	At about this point a change comes over the appearance in the phosphoroscope. The blue line of Gα is now the earliest to appear, and it is followed by the Gη red and Gβ green. No Gδ line is seen.
Yttrium 25%	Strontium 75%	These mixtures are very similar to each other in the phosphoroscope. The line of Gα comes first, next the Gη line, then Gβ line. No Gδ citron line has been seen in any of these mixtures.
,, 15	,, 85	
,, 5	,, 95	
,, 0·5	,, 99·5	

In a paper read before the Royal Society, June 18th, 1885,* I described the phosphorescent spectrum given by a mixture of 61 parts of yttrium and 39 parts of samarium,

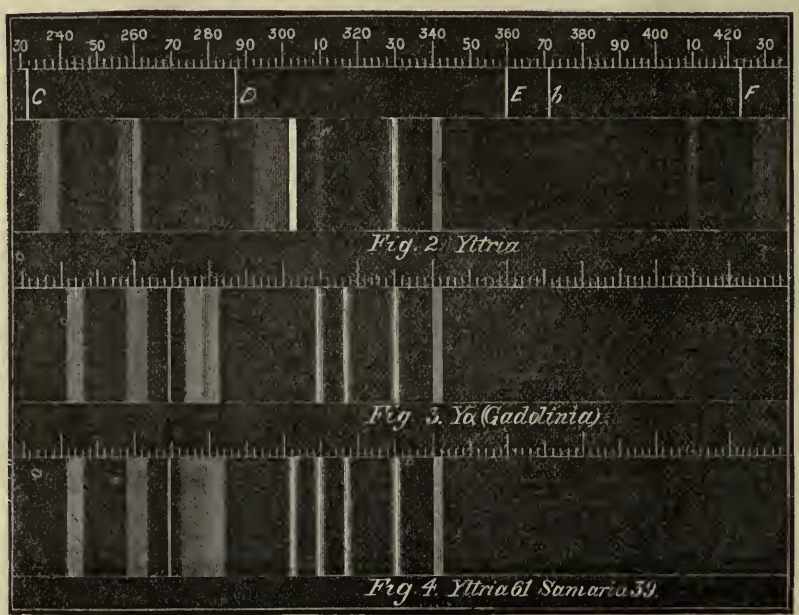


Fig. 2. Yttria

Fig. 3. Ya (Gadolinia)

Fig. 4. Yttria 61 Samaria 39

and illustrated it by a coloured lithograph. Also in a paper read before the Royal Society, February 25th, 1886,† I described and figured the phosphorescent spectrum of an earth obtained in the fractionation of yttria which was identical, chemically and spectroscopically, with an earth discovered by M. de Marignac, and provisionally called by him Yα. I repeat here these spectra, with the spectrum of yttrium added for comparison. Omitting minor details, it is seen that the Yα spectrum is identical with that of the mixture yttrium 61 samarium 39, with one important exception—the citron line of Gδ in the former spectrum is absent in the latter. Could I by any means remove Gδ from the mixture of yttrium and samarium the residue would be Yα. I have little doubt that this will soon be accomplished, but in the meantime the phosphoroscope enables us to remove the line of Gδ from the mixture. It is only necessary to add strontium to a suitable mixture of yttrium and samarium and view the phosphorescing mixture in the instrument when the wheel is rotating rapidly, to obtain a spectrum which is indistinguishable from that of Yα.

(To be continued.)

* *Phil. Trans.*, Part 2, 1885, p. 716.
† *Roy. Soc. Proc.*, vol. xl., p. 236.

RELATION OF THE CHEMICAL CONSTITUTION OF INORGANIC COMPOUNDS TO THEIR PHYSIOLOGICAL ACTION.

By Dr. JAMES BLAKE.

THE first fact I observed connecting the biological action of inorganic substances with their chemical constitution, was that when introduced directly into the blood their action was dependent on the electro-positive element of the compound, and was but slightly modified by the acid with which it was combined. I published this fact in a paper read before the Academie des Sciences, at Paris, in 1839.

The next generalisation that I arrived at was that the biological action of the compounds of the elements was connected with their isomorphous relations, the compounds of the elements in the same isomorphous group giving rise to analogous biological reaction. (This relationship was suggested to me by the late Prof. Graham, in whose laboratory I was working at the time, on my calling his attention to the fact that the salts of silver, when introduced into the blood, gave rise to the same reactions as the salts of soda.)

On working out this hypothesis, experiments with the salts of the magnesian and the baryta groups of metals fully confirmed the truth of Graham's supposition. These results were published in a paper read before the Royal Society in January, 1841, and the experimental investigation of the biological action of compounds of more than forty of the elements has since confirmed them, the salts of potash, however, forming an exception.

In a paper read before the Academie des Sciences, at Paris, in 1839, I had already shown that when introduced directly into the blood the biological action of a salt is determined by the electro-positive element, the sulphates, nitrates, arseniates, phosphates, chlorides, &c., of the same base causing the same biological actions.† This is evidently a corollary of the fact that connects the biological action of a substance with isomorphism, as these

* Paper read before the University College Chemical and Physical Society, on February 3rd, 1887.
† It would seem that in the nitrites, and in the pyrophosphates and pyrovanadates, the acid exerts some influence in intensifying the biological action of the base.

isomorphous relations are determined by the electro-positive element of the compound.

In a paper read before the Californian Academy of Sciences, in 1873, I published the fact that in the same isomorphous group the intensity of biological action is a function of the atomic weight; the higher the atomic weight of an element, in the same isomorphous group, the smaller the quantity required to cause the same amount of biological action.

When injected into the jugular vein, the first sensitive tissue with which the reagent is brought into contact is the blood-vessels in the lungs. These blood-vessels are a most delicate test for the alkaline elements, whose presence in the blood causes them to contract, and when in sufficient quantity they completely arrest the passage of the blood through the lungs. This reaction is caused not only by the more characteristic elements,—lithium, sodium, rubidium, cæsium, and thallium,—but also by those elements which are connected with them by isomorphous relations,—silver, gold, and lead. So delicate is this test that the presence in the blood of 1-50,000th part of its weight of a salt of gold can be readily detected,—not indeed as gold, but as a substance with chemical properties analogous to those of the alkaline metals.

There are other elements which cause contraction of the pulmonary vessels, yet none of the salts that have been used give rise to the same action on the lung tissue.

The next organ to which our reagents are applied is the heart, for, although they have been already in contact with the internal surface of the organ it is only after having passed the left ventricle and circulated through its tissues that any reaction takes place. The whole of the alkaline elements and those related to them keep up its contractions after respiration has ceased,—the lithia salts for from twelve to fifteen minutes, the rubidium salts for thirty-one minutes, and the gold salts for many hours after death, the presence of 1-50,000th the weight of the blood of a gold salt producing this reaction; the whole of the salts of the magnesia group and the baryta group destroy its irritability, suddenly arresting its action a few seconds after they have been introduced into the veins. The oxygen and hydrogen compounds of the chlorine group have the curious effect of keeping up the irritability of the ventricles after that of the auricles has ceased. After having passed through the heart the reagent is brought into contact with the arteries that carry it over the whole body. These vessels are affected by some of these inorganic substances in the same way as are the lung arteries by the soda group. The salts of the platinum group cause them to contract, although they do not affect the lung-vessels, whilst the salts of the soda group which act on the lung arteries pass through the systemic arteries without affecting them. The salts of the alumina group contract both the systemic and pulmonary arteries, whilst the salts of the magnesian group affect neither.*

The next important organs with which our reagents are brought into contact are the nerve-centres. In the medulla oblongata are various centres regulating distinct functions, although hardly to be distinguished anatomically. Amongst these are the respiratory centre, the vasometer centre, the vomiting centre, &c. The salts of the platinum group exert a marked action on the respiratory centre, the salts of the magnesian group react on the vomiting centre, the thorium salts on the vasometer centre, and the baryta group on the cord, whilst the salts of the more typical alkaline metals have no action on any part of the nervous system. The salts of the magnesian group and the platinum group interfere with the coagulation of the blood. These elements which form connecting-links between two isomorphous groups cause biological reactions which are common to the two groups,—the salts of lead, for example, acting on the lung-vessels as do the alkaline elements, and on the spinal cord in the same manner as the baryta group of salts.

When an element forms two classes of salts the biological action of each class is perfectly distinct, each producing the reactions characteristic of the isomorphous group to which it belongs. Thus the ferrous salts agree with the other members of the magnesian group, and the ferric salts with the other members of the aluminum group in their biological action. If we now consider the relation between atomic weight and biological action, we shall find this is not shown by any effect on the general biological action of the compound, but by the fact that in the same isomorphous group the *intensity* of biological action is increased with the atomic weight; the greater the atomic weight of an element the smaller the quantity required to cause the same amount of biological action. This connection is not so marked as that which exists between the isomorphous relations of the elements and their general biological action, slight modifications in chemical properties apparently exerting a greater influence on this quantitative reaction than on the qualitative, nor is it found at all among the more electro-negative elements.*

The following figures show the quantity expressed as oxide of the elements, with the highest and lowest atomic weights, in each isomorphous group, that are required per kilo. of animal to cause the same amount of biological action:—

Lithium	0·420	Magnesia ..	0·031
Thallium.. ..	0·023	Cadmium ..	0·026
Lime	0·220	Beryllium ..	0·023
Baryta	0·025	Ferric oxide ..	0·003

Such is a summary of the facts that have been ascertained in testing the biological action of compounds of more than forty of the elements, by introducing them directly into the blood of living animals.†

As to the nature of these reactions—whether they are analogous to any that take place between other forms of matter, or whether they constitute a class apart which has yet to be recognised—it would at present be premature to give an opinion. There are, however, some considerations which would lead us to connect them with contact relations, so that the changes that are constantly going on in the living tissues, and on which the functions of each organ depend, are modified in different directions by mere contact with these inorganic substances. As our living reagents are substances of high molecular weight, and in a state of constant change, they are of all forms of matter most likely to be the seat of contact reactions, and will, I think, be useful in elucidating this branch of chemistry. Experiments by Dujardin, Beaumetz, and Audigé render it highly probable that the connection between chemical properties and biological action that has been proved with inorganic substances is also to be found in the carbon compounds. They show that all the alcohols in the same series cause analogous biological reactions, and also that, as in the different isomorphous groups, the toxic power increases with the atomic weight. Schmerdehery has also shown that the biological action of the ether salts is dependent on the electro-positive molecule, and is but slightly influenced by the acid with which it is combined.

Should these observations be generalised, living matter will prove an important reagent in determining the chemical constitution of the carbon compounds.

* These effects both on the systemic and pulmonary arteries can be readily observed by means of a manometer.

* It should be remembered that our knowledge of the connection between the general chemical properties of the elements and isomorphism is still imperfect,—in fact, has advanced but little beyond the point where Mitscherlich left it seventy years ago. Our classification, too, of the elements in isomorphous groups implies nothing more than a general family resemblance between the elements in the same group, admitting undoubtedly of considerable modifications in their chemical properties.

† Details of these experiments will be found in *Proc. Roy. Soc.*, vol. v., 1841; *Reports of Brit. Assoc.* for 1843, 1845, 1846; *Journal of Physiology*, vol. v.

INVESTIGATION ON THE ATOMIC WEIGHT OF TUNGSTEN.

By JOHN WADDELL, Ph.D. (Heidelberg), D.Sc. (Edin.).

(Concluded from p. 102).

THE fractionations were made in the following manner:—To the boiling solution in a porcelain basin 20 to 30 c.c. hydrochloric acid, 1·135 sp. gr., were added, and the boiling continued till considerable precipitate appeared. The contents of the basin were then removed to a large beaker (about 2 litres), and hot water added (if necessary) to fill the beaker. When the tungstic acid had settled, the clear supernatant liquid was decanted and the precipitate washed twice by decantation. Further washing was impossible, unless with addition of hydrochloric acid, for the tungstic acid did not settle, but made the liquid milky. Sometimes the acid necessary for the subsequent precipitation was added to the last washing. The decantations were evaporated to the bulk of the original solution, and if the requisite acid had not before been added it was now poured in and another precipitation obtained.

In this way eleven fractionations were prepared of these: the first was dark green, those following as far as the seventh were light yellow, while the remaining ones were dirty green and not so finely divided as the preceding. The colour of the first precipitate was probably due to want of complete oxidation by the current of air passed through the liquid, while the condition of the final fractionations was doubtless caused by the fact that, in order to get a reasonable quantity of the tungstic acid, evaporation to small bulk was required. The tartaric acid probably under these circumstances exercised a reducing action, while the continued boiling promoted coagulation.

For the atomic weight determinations three of these fractionations were purified,—viz., III., X., and VII. A description of the treatment of III. will show the general method. The precipitate was washed several times by decantation, and then repeatedly on a filter with very dilute (say 3 per cent) hydrochloric acid. It was afterwards dissolved in ammonia, filtered from the very trifling residue, and re-precipitated by hydrochloric acid (the best method is by pouring the boiling solution into excess of hydrochloric acid). This precipitate was again washed by decantation and on the filter till the washings yielded no residue on evaporation, and a test portion of the precipitate gave only a slight indication of sodium by the spectroscope.

The hydrochloric acid was freed from a possible trace of arsenic by digestion with copper-foil, and was afterwards three times distilled. The ammonia was re-distilled from baryta. Both it and the acid were proved to be free of anything leaving a solid residue on evaporation. The precipitate was dried, powdered, and heated to redness in a current of air, in order to get rid of the last traces of hydrochloric acid and ammonium chloride, and to ensure complete oxidation. This ignition lasted several hours. The tungstic acid thus obtained was quite uniform in appearance, and of a beautiful pale canary-yellow colour.

Some of this tungstic acid was afterwards reduced in a current of hydrogen (purified by passing through large U-tubes containing pumice moistened respectively with lead nitrate, silver nitrate, caustic potash, and strong sulphuric acid). Care was taken to increase the temperature gradually, in order to prevent the tungstic acid from volatilising before reduction. The temperature was finally raised to the highest attainable by a strong blast in Fletcher's furnace. The material before and after reduction was weighed in a porcelain boat enclosed in a glass weighing tube, and counterbalanced by a similar tube containing an empty boat. In order to see whether volatilisation had taken place, the porcelain tube in which the substance had been heated was wiped out with cotton-wool, and when the wool remained perfectly clean it was assumed that there had been no volatilisation. Several experiments showed that very slight amounts of volatilisation were capable of being thus detected. At the highest temperature of the furnace there was danger of the boat fusing to the tube unless protected in some way. The plan adopted was to wind a couple of pieces of platinum wire about the boat. Contact with the tube was thus prevented.

I assumed, as has always been done, that hydrogen reduces tungstic acid to metallic tungsten. I proved that no hydrogen is occluded by weighing one specimen of the metal obtained as above, and afterwards heating it to redness under diminished pressure and again weighing. The weight was constant. The fraction X., to which XI. was added, was subjected to the same treatment as III., but never attained the same stage of apparent purity. During the reduction, too, a slight volatilisation occurred. I therefore purified VII. with quite satisfactory results, and the atomic weight determination was only slightly below those obtained with III. Subjoined is a table of determinations:—

Fraction.	WO_3 taken.	W left.	O_3 lost.	Atomic weight.	Remarks.
III.	*1·4006	1·1115	0·2891	184·55	No volatilisa-
	0·9900	0·7855	0·2045	184·37	[tion.
	1·1479	0·9110	0·2369	184·59	
VII.	0·9894	0·7847	0·2047	184·00	[isation.
X.	4·5639	3·6201	0·9438	183·67	Slight volatil-

The mean of the atomic weights as determined in III. is 184·5, if oxygen be regarded as 16. If O = 15·96, then W = 184·04. The estimation in VII. so nearly agreed with the others that it was not thought necessary to make any further determinations.

I think there can be no doubt that the commonly accepted atomic weight is practically correct. It is useless to attempt to be more accurate while the atomic weights of such elements as oxygen are open to dispute.

I made some determinations of atomic weights in precipitates from tungstate which had not been freed from molybdenum. The first fractionation was most carefully examined. It might naturally be expected to contain the greater portion of the molybdic acid, in which case a low result was to be looked for, not only because the atomic weight of molybdenum is only about half that of tungsten, but also because the experimental error of volatilisation is more difficult to avoid. A very slight volatilisation was observed, and as a mean of four experiments the number 183·68 was obtained. These determinations may be considered confirmatory of the more accurate ones, for the variation was just in the direction to be expected. Of course by themselves they are of little value.

The precipitates obtained by fractionation gave practically concordant results, and hence pointed to absence of impurity. I, however, tested independently for silica by fusing with sulphate. A test experiment proved that the sodium salt acted in the same way as the potassium salt. To the mixed sodium tungstate and carbonate which had been used for my investigations I added a few drops of strong sulphuric acid, and fused as described in the Appendix. No silica was found.

I made two determinations of specific gravity,—one of metal not specially freed from molybdenum, another of a portion of III. which was considered pure. The numbers obtained were 18·25 and 18·77. These so nearly corresponded with the determinations of other investigators that I did not pursue the matter further. The second determination is doubtless the more accurate.

The result of my work has therefore been confirmatory of the accuracy of previous investigations. So far as I am aware, the method of operation has not been applied to tungsten before, and the agreement affords a trustworthy corroboration.

* Weights are in grammes.

Appendix.

The separation of silica and tungstic acid by fusion with potassium hydrogen sulphate is troublesome unless attention be paid to some important details. About equal weights of the sulphate and mixture of tungstic acid and silica are fused till the evolution of sulphuric anhydride almost ceases. The fused mass should then be limpid and flow quietly. This is the stage when the acid sulphate, $KHSO_4$, is changed to the compound $K_2S_2O_7$. The silica should be seen floating about in the fused mass. The crucible having been cooled, the fused mass should be powdered and added to boiling water. After further boiling, the undissolved material should be allowed to settle, and the supernatant liquid decanted through a filter. Fresh water is added to the residue, and again boiled and decanted. Further washing with pure water will probably be found impracticable, because the precipitate tends to run through the filter. Dilute ammonium carbonate should then be employed. This dissolves the remaining tungstate, as well as tungstic acid, the silica being left unattacked. After the precipitate is removed to the filter it should be washed a number of times with hot water containing ammonium carbonate.

As the last traces of tungsten are difficult to wash out, it is probably necessary for exact quantitative separation to dry the precipitate and fuse again with a little acid sulphate. In quantitative estimation, also, it will not be easy to powder the fused mass without loss. It is therefore best, under such circumstances, to remove the mass in lumps and digest with water for a longer time. The operation is slower, but otherwise equally good.

To dissolve tungstic acid in ammonia it is best to have the substance in a bottle. Then add a moderately strong but not saturated solution of ammonia, shake violently for several minutes, allow to settle, and decant the most of the supernatant liquid; add water to the remainder and shake again. Decant as before, and repeat the process if necessary. It may then be necessary to add a little more ammonia, but in most cases the tungstic acid will be entirely dissolved. It is of little, if any, advantage to use hot water. — *American Chemical Journal*, August, 1886, p. 280.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, March 3rd, 1887.

Dr. Hugo Müller, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. James Warne Chenhall, Churston, near Brixham, Devon; George Collar, B.A., 28, Sterndale Road, West Kensington Park, W.; Hugh Gordon, 3, Courtfield Gardens; David Lloyd Howard, Rectory Manor, Walthamstow; Edward Rawlins, Burley Road, Leeds; Louis H. Schubart, 201, West 125th Street, New York.

The following were elected Fellows of the Society:—Messrs. Cecil Howard Cribb, Leonard Dobbin, Joseph F. Geisler, Edgar Hall, Alexander Hay, Thomas A. Hedley, John S. Jackson, George McGowan, Gerald T. Moody, Joseph W. O'Connor, Henry D. Richmond, Arthur H. F. Ruppel, W. Scrutton, Henry Lloyd Snape, B.Sc., Arthur Stanley, Henry Wallis.

The following papers were read:—

18. "*Tartaric and Racemic Acids, and the Magnetic Rotatory Power of their Ethyl Salts.*" By W. H. Perkin, Ph.D., F.R.S.

The author has very carefully determined and compared certain physical properties of the diethylic salts of ordinary tartaric and racemic acids, prepared by the usual method by saturating the alcoholic solution of the acid with hydrogen chloride. Both boil at 232° to 233° (corr.) under a pressure of 197 m.m. They have the same relative density, viz.:—

Diethylic tartrate .. $d\frac{15^\circ}{15^\circ} = 1{\cdot}20972$ $d\frac{25^\circ}{25^\circ} = 1{\cdot}20189$.

,, racemate . $d\frac{15^\circ}{15^\circ} = 1{\cdot}20983$ $d\frac{25^\circ}{25^\circ} = 1{\cdot}20214$.

They have also the same mean molecular magnetic rotatory power, viz.:—

Diethylic tartrate at 14·8° = 8·766
,, racemate at 15·5° = 8·759.

It may therefore be concluded that the racemate is a mixture of the two tartrates.

Racemic is distinguished from tartaric acid by crystallising with 1 mol. proportion of water; the author finds that silver racemate, like the tartrate, is anhydrous. In preparing silver tartrate he obtained an acid salt,—

$$C_4H_5AgO_6{\cdot}H_2O,$$

crystallising in well-defined monoclinic prisms, measurements of which by Prof. Haushofer are given. An acid silver racemate appears also to exist, but is much less soluble than the tartrate, and the crystals are small.

The relative densities of aqueous solutions of the two acids were determined, using (*a*) a solution containing 8·333 per cent, and (*b*) a solution containing 25 per cent, the latter being supersaturated in the case of racemic acid: the results are—

	(*a*)	(*b*)
Tartaric acid solution	$d\frac{15^\circ}{15^\circ} = 1{\cdot}03703$	$d\frac{15{\cdot}3^\circ}{15^\circ} = 1{\cdot}12346$.
Racemic acid solution	$d\frac{15^\circ}{15^\circ} = 1{\cdot}03712$	$d\frac{15{\cdot}3^\circ}{15^\circ} = 1{\cdot}12398$.

The relative densities of the solid acids were also determined:—

Racemic acid, $C_4H_6O_6{\cdot}H_2O$ .. $d\frac{7^\circ}{4^\circ} = 1{\cdot}6873$,

,, ,, dehydrated .. .. = 1·7782.
Tartaric acid .. .. = 1·7594.

These results, the author considers, point to the conclusion that on dissolving in water racemic acid separates into the two tartaric acids, only a small quantity remaining unchanged. He is of opinion that the water is present in crystallised racemic acid as such; and he finds that, if the hydrated acid be crystallised from absolute alcohol, well-defined anhydrous crystals are obtained much less soluble than tartaric acid in alcohol.

19. "*Anhydracetonebenzil.*" By Francis R. Japp, F.R.S., and Cosmo Innes Burton, B.Sc.

Anhydracetonebenzil (formerly *dehydracetonebenzil*), $C_{17}H_{14}O_2$, was originally prepared by Japp and Miller (*Trans.*, 1885, 27) by the condensation of benzil with acetone under the influence of caustic potash; they concluded that it contained a closed chain formed by the interaction of the acetone with the lateral chain of the benzil. The authors adduce further evidence in support of this view.

Anhydracetonebenzil reacts with phenylhydrazine, forming the compound $C_{17}H_{14}O(N_2H{\cdot}C_6H_5)$ (slender, yellow needles, melting at 197°), which is not altered by heating with excess of phenylhydrazine.

By boiling anhydracetonebenzil for a few minutes with iodhydric acid it is deprived of an atom of oxygen, and yields a compound, $C_{17}H_{14}O$ (colourless prisms from alcohol, m.p. 110°). This reacts with phenylhydrazine, forming $C_{17}H_{14}(N_2H{\cdot}C_6H_5)$, which crystallises from alcohol in rosettes of short yellow needles, melting with decomposition at 170° to 180°.

Fuming iodhydric acid and amorphous phosphorus at 130° convert anhydracetonebenzil into a hydrocarbon,

$C_{17}H_{18}$, which crystallises from alcohol in colourless, long, flat needles, melting at 47°, and distilling under ordinary pressures with partial decomposition at 305° (uncorr.). The authors regard this hydrocarbon either as diphenylpentamethylene (1, 2), or as phenylbenzyltetramethylene (1, 1). It is not reduced to $C_{17}H_{20}$ by the action of the hydriodic acid at a higher temperature, as it would be if it were an unsaturated open-chain compound—diphenylamylene.

By reduction with tin and hydrochloric acid in alcoholic solution, anhydracetonebenzil is converted into a compound, $C_{34}H_{34}O_2$, very sparingly soluble in alcohol, from which it crystallises in lustrous, minute rhomboidal plates, melting at 187° to 188°.

When boiled with sulphuric acid diluted with twice its volume of water, 2 mols. of anhydracetonebenzil part with 2 mols. of water, and unite, forming a compound, $C_{34}H_{24}O_2$, which crystallises from benzene in two forms—one with, the other without, benzene of crystallisation. This substance melts with decomposition at 195° to 200°, evolving exactly one molecular proportion of carbonic oxide, according to the equation—

$$C_{34}H_{24}O_2 = C_{33}H_{24}O + CO.$$

The compound $C_{33}H_{24}O$ crystallises from benzene in small plates of the formula $C_{33}H_{24}O,C_6H_6$, which, after expelling the benzene, melt at 162° to 163°. It reacts with phenylhydrazine, yielding $C_{33}H_{24}(N_2H{\cdot}C_6H_5)$ (pale yellow, slender needles, very sparingly soluble in alcohol, m.p. 250°. In this respect it differs from its parent compound, $C_{34}H_{24}O_2$, which does not react with phenylhydrazine.

Anhydracetonebenzil, when treated with concentrated alcoholic chlorhydric acid in the cold, is converted into a compound, $C_{17}H_{13}ClO$, which crystallises from alcohol in flat needles with a silky lustre (m.p. 128°). When this compound is heated with alcoholic ammonia at 100°, it yields the condensation product, $C_{34}H_{24}O_2$ (m.p. 195° to 200°), already described.

When oxidised with dilute nitric acid, anhydracetonebenzil yields chiefly benzoic acid, together with paranitrobenzoic acid, oxalic acid, benzil, and a small quantity of a neutral nitrogenous substance crystallising in needles (m.p. 264°).

The authors have also commenced the study of the reactions of *anhydracetophenonebenzil*, $C_{22}H_{16}O_2$ (Japp and Miller, *Trans.*, 1885, 36), which was not supposed by its discoverers to contain a closed lateral chain. This compound appears to react both with 1 and with 2 mols. of phenylhydrazine, but neither of the derivatives thus formed could be obtained free from the other. When boiled with fuming iodhydric acid it is transformed like anhydracetonebenzil, parting with an atom of oxygen, and yielding a compound, $C_{22}H_{16}O$ (long flat prisms from alcohol, m.p. 92° to 93°). With alcoholic chlorhydric acid in the cold anhydracetophenonebenzil behaves like anhydracetonebenzil, forming a compound, $C_{22}H_{15}ClO$, which crystallises from alcohol in colourless slender needles, melting at 115°.

20. "*Condensation Compounds of Benzil with Ketones.*" By the same.

In order to ascertain whether the reaction in which anhydracetonebenzil and anhydracetophenonebenzil are formed (see foregoing note) is of general application, the authors have examined the action of benzil with various homologues of acetone. Caustic potash, of sp. gr. 1·27, was used as the dehydrating agent. In every case 1 mol. of benzil was found to react with 1 mol. of the ketone, eliminating 1 mol. of water. The intermediate additive compounds, the formation of which was observed in the case of the reactions of benzil with acetone and acetophenone (Japp and Miller, *Trans.*, 1885, 21 and 34), were not isolated.

The following compounds, which for purposes of nomenclature are *assumed* to be true homologues of anhydracetonebenzil have been prepared:—

Methyl-anhydracetonebenzil, $C_{18}H_{16}O_2$. From methylethylketone and benzil. Colourless thin prisms from alcohol; m.p. 179°.

Dimethyl-anhydracetonebenzil, $C_{19}H_{18}O_2$. From diethylketone and benzil. Colourless rhomboidal plates from alcohol; m.p. 150°.

Ethyl-anhydracetonebenzil, $C_{19}H_{18}O_2$. From methylpropylketone and benzil. Colourless minute needles from alcohol; m.p. 156°.

Amyl-anhydracetonebenzil, $C_{22}H_{24}O_2$. From methylhexylketone and benzil. Tufts of colourless slender silky needles from alcohol; m.p. 150°5°.

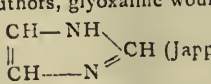
21. "*Constitution of Glycosine.*" By Francis R. Japp, F.R.S., and E. Cleminshaw, M.A.

Debus showed (*Phil. Trans.*, cxlviii., 209) that glyoxal reacts with ammonia according to the two equations—

I.. .. $3C_2H_2O_2 + 4NH_3 = N_4(C_2H_2)_3^{iv} + 6H_2O.$
(Glyoxal. Glycosine.)

II.. .. $2C_2H_2O_2 + 2NH_3 = C_3H_4N_2 + CH_2O_2 + 2H_2O.$
(Glyoxal. Glyoxaline. Formic acid.)

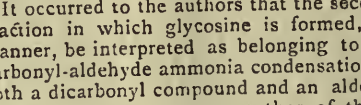
Radziszewski (*Ber.*, xv., 1495) has suggested that the second of these reactions occurs in two stages. In the first stage, 1 mol. of glyoxal is hydrolysed, yielding formic aldehyde and formic acid; in the second, the formic aldehyde reacts with another mol. of glyoxal and 2 mols. of ammonia, forming glyoxaline. Interpreting this second stage by the light of the condensations of dicarbonyl-compounds with aldehydes and ammonia, studied by one of the authors, glyoxaline would receive the formula—



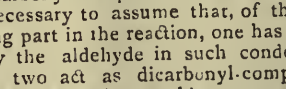
(Japp, *Trans.*, 1883, 17).

This formula is in keeping with the reactions of the compound, and has found general acceptance.

It occurred to the authors that the second of the above reaction in which glycosine is formed, might, in like manner, be interpreted as belonging to the class of dicarbonyl-aldehyde ammonia condensations, glyoxal being both a dicarbonyl compound and an aldehyde. It would only be necessary to assume that, of the 3 mols. of glyoxal taking part in the reaction, one has the function exercised by the aldehyde in such condensations, whilst the other two act as dicarbonyl-compounds. On this assumption the reaction would occur according to Equation II. (*Trans.*, 1884, 672) of the general reactions of this class, save that in the present case, as the aldehyde is a dialdehyde, the molecular proportions of the other reacting substances are doubled:—



Glyoxal as dicarbonyl-compound. Glyoxal as aldehyde.

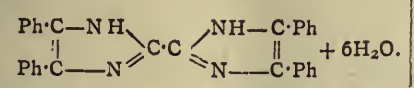


Glycosine.

The glyoxal molecule of aldehyde function reappears as an oxalic acid residue in the formula of glycosine; the two glyoxal molecules of dicarbonyl function reappear in the form of two unsaturated groups—CH : CH—(comp. *Trans.*, 1884, 673). In this respect the reaction would belong to the numerous class involving mutual oxidation and reduction between similar molecules, to which class the aldehydes furnish the largest contingent.

If the foregoing view is correct, it should be possible to substitute, in the foregoing reaction, for the two glyoxal molecules of dicarbonyl function, two diketone molecules containing the group CO·CO. Thus, by the action of ammonia on a mixture of benzil and glyoxal, a *tetraphenyl-glycosine* should be formed:—

$$2\begin{matrix} C_6H_5\cdot CO \\ | \\ C_6H_5\cdot CO \end{matrix}\begin{matrix} CHO \\ | \\ CHO \end{matrix} + 4NH_3 =$$



$$+ 6H_2O.$$

This was found to be the case. Tetraphenylglycosine, prepared by the above method, crystallises from alcohol in long, very slender, silky needles, $C_{30}H_{22}N_4,C_2H_6O$, which readily part with their alcohol of crystallisation. It melts above 300°. It forms unstable salts.

Debus formulates glycosine as a tertiary amine on the quadruple ammonia-type (see reaction I). The formula above suggested differs from this in containing two imido-groups. In order to prove the presence of two displaceable hydrogen-atoms, the authors heated glycosine with benzyl chloride, and obtained *dibenzylglycosine*,—

$$C_6H_4N_2(N\cdot C_7H_7)_2,$$

which crystallises from alcohol in oblique plates melting at 145°.

The authors have also prepared some new platinichlorides of glycosine. In addition to the diacid salt, $C_6H_6N_4,H_2PtCl_6$, described by Debus, they have obtained a *monacid salt*, $(C_6H_6N_4)_2H_2PtCl_6$, the existence of which was suspected by Debus, and a *tetracid salt*,—

$$C_6H_6N_4(H_2PtCl_6)_2,$$

the latter being, of the three, that which is most readily prepared in a pure state.

A suggestion regarding the constitution of glycosine, similar to that here developed, has been thrown out by Wallach. He says, *Ber.*, xvi., 545, footnote) :—"Glycosine probably stands in the same relation to glyoxaline as dioxalethyline to oxalethyline." It is to be remarked, however, that dioxalethyline appears to be derived from an isomeride of glycosine, in which the two glyoxaline complexes are united at a different point.

22. "*Diphenylglyoxaline and Methyldiphenylglyoxaline.*" By Francis R. Japp, F.R.S.

The author received from Mr. W. Palmer Wynne a small quantity of a base, melting at 218°, obtained, together with imabenzil, benzilimide, and benzilam by dissolving benzil in warm methylated spirit and saturating the solution with ammonia. This base remained in the last mother-liquors.

The author failed to obtain it on substituting pure alcohol for methylated spirit. An attempt was then made to prepare it, employing methylated spirit; but the only basic substance obtained was methyldiphenylglyoxaline (m. p. 235°), showing that the spirit contained aldehyde. An old specimen of wood-spirit was then used. A new base was then obtained, which was deposited from alcohol in crystals not unlike those of Mr. Wynne's base, but melting at 227°. This proved to be *diphenylglyoxaline*, formed by the condensation of formaldehyde, contained in the wood spirit, with benzil and ammonia. The crystals differ in form according as they are deposited from hot or from cold alcohol—the latter form only resembling that of Mr. Wynne's base.

Analysis of Mr. Wynne's base gave figures intermediate between those required for diphenylglyoxaline and methylglyoxaline. A mixture of these compounds in molecular proportions was therefore allowed to crystallise from alcohol. The solution deposited crystals indistinguishable from those of Mr. Wynne's base, and, like these, melting at 218°. Finally, Mr. L. Fletcher has established the identity by crystallographical measurements. The hydrochlorides of the mixed bases also crystallise together in forms identical with those of the hydrochloride of Mr. Wynne's base.

23. "*Dehydracetic Acid.*" By W. H. Perkin, Jun., Ph.D.

It is known that if dehydracetic acid, $C_8H_8O_4$, be treated with alkalis, it is decomposed principally into acetic acid, carbonic anhydride, and acetone, a small quantity of malonic acid also being formed.

The author finds, however, that in the first place dehydracetic acid is converted into two molecules of acetoacetic acid, $C_8H_8O_4 + 2H_2O = 2CH_3\cdot CO\cdot CH_2\cdot COOH$. Dehydracetic acid reacts with phenylhydrazine and with hydroxylamine, forming the compounds—

$$C_7H_8O_3(N_2H\cdot C_6H_5)$$

and $C_7H_8O_3(N\cdot OH)$; and it therefore contains a carboxyl-group. The fourth oxygen-atom (not counting the carboxyl-group) is present neither as CO nor as OH, and the author therefore proposes the formula—

$$\begin{matrix} & & C\cdot CO\cdot CH\cdot COOH \\ & & \| \quad \| \\ CH_3\cdot C & \cdot O \cdot & C\cdot CH_3 \end{matrix}.$$

The action of aniline on methylic dehydracetate, in the author's opinion, is such as to prove the correctness of this expression, two substances, *methylic phenyldimethylpyridine carboxylate* and *phenyldimethylpyridone*, being formed, which are both pyridine-derivatives, viz. :—

$$\begin{matrix} C\cdot CO\cdot C\cdot CO_2CH_3 \\ \| \quad \| \\ CH_3\cdot C\cdot NPh\cdot C\cdot CH_3 \end{matrix} \quad \text{and} \quad \begin{matrix} CH\cdot CO\cdot CH \\ \| \quad \| \\ CH_3\cdot C\cdot NPh\cdot C\cdot CH_3 \end{matrix}.$$

An interesting synthetical proof of the correctness of the formula assigned to dehydracetic acid has lately been given by Conrad and Guthzeit (*Ber.*, xx., 154).

24. "*The Colouring-matter of Drosera Whittakeri.*" By Prof. E. H. Rennie, M.A., D.Sc.

The author's attention was drawn to the presence of a red colouring-matter in the tubers of the above-mentioned *Drosera*, which grows plentifully on the hills near Adelaide, South Australia, by Prof. Tate. On inquiry he ascertained that Mr. Francis, of Adelaide, had extracted the colouring-matter by means of carbon bisulphide, and had found that it was volatile, and that beautiful tints could be produced with it on silk by means of various mordants, but had not continued the investigation. To separate the colouring-matter the tubers were heated with hot strong alcohol. After distilling off the spirit a little water was added, and the precipitated colouring-matter was then dried and sublimed; the product was a mixture of two substances differing in solubility in boiling alcohol and acetic acid. The less soluble was obtained in small brilliant red plates, canoe-shaped under the microscope, which melted at 192° to 193°. Analysis gave numbers fairly agreeing with those required by the formula $C_{11}H_8O_5$, which may represent a *trihidroxy-methylnaphthaquinone*. The reactions of the substance, in so far as they could be studied with the small quantity of material at disposal, serve to support the view that it is thus constituted. The second substance was finally obtained in needles, quite different in appearance from the red plates, though to the eye of much the same colour. Under the microscope single crystals seemed yellow, but wherever they overlapped the colour appeared deep orange to red. It fused at 164° to 165°. Analysis gave numbers fairly agreeing with the formula $C_{11}H_8O_4$.

25. "*Further Notes on the Di-haloid Derivatives of Thiocarbamide.*" By George McGowan, Ph.D.

The author has succeeded in obtaining dithiocarbamide dibromide in beautiful large rhombic crystals, by the action of bromine on an aqueous solution of thiocarbamide. At the ordinary temperature it is quite stable. By the further action of bromine on an aqueous solution this dibromide is converted into carbamide, or, more probably, in the first instance into cyanamide, hydrobromic and sulphuric acids being produced at the same time.

Sulphuretted hydrogen acts on dithiocarbamide dichloride, $(CSN_2H_4)_2Cl_2$, in alcoholic solution, producing thiocarbamide hydrochloride, $CSN_2H_4\cdot HCl$, and sulphur.

All attempts to prepare the dicyanide, $(CSN_2H_4CN)_2$, have failed. From the results of a number of experiments with different cyanides on thiocarbamide and its dichloride,

the author concludes that probably the dicyanide is formed, but immediately breaks up, the separated sulphur being taken up by the excess of cyanide present and thiocyanate formed.

At the next meeting, on March 17th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Action of Heat on Nitrogen Peroxide," by Dr. A. Richardson.

"The Formation of Naphthalene-sulphonic Acids by means of Sulphuric Anhydride," by Dr. Armstrong and W. P. Wynne, B.Sc.

CORRESPONDENCE.

MOLTEN IRON.

To the Editor of the Chemical News.

Sir,—I have not noticed the transparency of molten iron mentioned by Mr. Ramsay, but I have observed a rapid formation on the surface of molten iron of a curious reticulated geometrical pattern. The brilliant golden appearance of the fluid metal is very beautiful, and the operation of casting is a spectacle of deep interest.—I am, &c.,

C. R.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 5, January 31, 1887.

Metals and Minerals from Ancient Chaldæa: on the Sources of Tin in the Ancient World.—M. Berthelot.—The author has examined four tablets from the ruins of Nineveh; one is of gold, another of silver, a third of bronze (containing 10 per cent of tin), and the fourth of pure crystalline magnesium carbonate. A portion of a vase from Tello was found to consist of antimony, containing no appreciable trace of copper, lead, bismuth, or zinc. The author points out this extreme antiquity of the metallurgy of antimony as a remarkable fact. Tin is said to have been anciently obtained from the western parts of Afghanistan.

Combinations of Sodium Glycerinate with the Monoatomic Alcohols.—M. de Forcrand.—Not capable of useful abstraction.

The Comparative Effects of Heat and of Solar Light.—E. Duclaux.—All the actions of combustion which heat can produce may be also produced by light, but the converse does not hold good. There are many reactions which light alone seems able to set up. All these reactions may be summed up as a disturbance of the primitive molecule which is decomposed into simpler elements. These elements are few in number: they are, if we limit ourselves to volatile bodies, formic, acetic, and butyric acids, methylic and ethylic alcohols, and ethylic aldehyd. These stable groups are generally found the same with one and the same body, whatever the source from which it derives its oxygen. But this is not always the case. Thus lactic acid, if burnt by means of atmospheric oxygen, yields acetic acid, but produces butyric acid if it obtains its oxygen from the salts of mercury. These stable residues of combust on do not pre-exist as groups in the original molecule, but result from a new arrangement of the molecules during combustion. This is proved by the fact that they are found identical in bodies of different types, and are not always the same with one and the same body. These products contain a smaller number of molecules of hydrogen and carbon than the bodies whence they are derived. The sole exceptions to this rule, the formation of formic acid at the expense of oxalic acid, and that of butyric acid from lactic acid, disappear if we double the formulæ of oxalic and lactic acids. Potassium permanganate, which often acts in the cold and in darkness, does not yield other products than those resulting from the action of the sun and of heat. The bodies which it attacks best are those which are found least stable under other oxidising conditions. But if it does not occasion any novel facts, we may study with it very conveniently the circumstances of the experiment and the conditions of initial and final acidity or alkalinity which determine the result. These last conditions play a great part in the combustions made at the expense of oxygen, free or combined.

The Properties of Inosite.—M. Maquenne.—By the action of reducing agents inosite is converted into a phenol. By means of nitric acid it is transformed into tetra-oxyquinone.

A Compound of Paratoluidine and Cupric Chloride.—E. Pomey.—On mixing hydrochloric solutions of these two substances and heating the liquid to a boil, golden-yellow crystals are gradually deposited.

Composition of the Seeds of Holcus Sorgho, and their Application in Agricultural Industry.—M. Bordas.—These seeds contain 42 per cent of starch, and, according to the author's experiments, yield, per 100 kilos., 26 litres of alcohol of a good quality.

No. 6, February 7, 1887.

Red Fluorescence of Alumina.—Lecoq de Boisbaudran.—The writer now finds that, after a very energetic ignition, alumina gives a red fluorescence in a vacuum under the action of the electric effluve, as had been pointed out by M. Becquerel. The latter savant added some remarks, which we reproduce elsewhere *in extenso*.

Composition of the Ash of Cider.—G. Lechartier.—The samples analysed gave quantities of ash varying from 1·7 to 4·9 grm. per litre. The proportion seems to augment at the same time as do the alcohol and the organic principles. From 80 to 92 per cent of the ash is soluble, consisting almost entirely of salts of potash. Soda is found only in traces, and lime not at all. The two predominant acids are the phosphoric and the carbonic. The insoluble portion of the ash contains lime, magnesia, silica, ferric oxide, and alumina.

Electrolysis of Alkaline Solutions.—M. Duter.—On electrolysing aqueous solutions of potassa, soda, baryta, or lime, the author has found the volume of oxygen evolved at the positive electrode strikingly less than the half of that of the hydrogen liberated at the negative electrode. There seem to be formed small quantities of a peroxidised compound, which is combined with the alkali in such a manner that it cannot be liberated by ebullition, but only by an acid. This compound may be a hydrogen peroxide, by the existence of which M. Berthelot explains various reactions, including that of potassium permanganate upon oxygenated water.

The Principle of Maximum Work and the Laws of Chemical Equilibrium.—H. le Chatelier.—The author concludes that:—"In phenomena of simple dissociation, the quotient of the absolute dissociation-temperature under the atmospheric pressure into the latent heat of decomposition at the same temperature, and referred to the volatilisation of a molecular weight of the gaseous bodies is a constant quantity. This law is applicable only to systems which are strictly comparable, that is, which

possess, at a given temperature, a determinate tension. This law may be approximated to the laws of Faraday and Gay-Lussac, which also establish relations between the chemical equivalents of bodies, and some of their physical properties.

Action of Lead Oxide upon Certain Dissolved Chlorides.—G. André.—The author has studied the behaviour of lead oxide with calcium, barium, strontium, and magnesium chlorides.

Combinations of Potassium Glycerinate with Monoatomic Alcohols.—M. de Forcrand.—A thermochemical memoir, which does not admit of useful abstraction.

On Phospho-platinous Chloride.—E. Pomey.—This compound, if brought in contact with water, exchanges the chlorine combined with the phosphorus for hydroxyl, yielding a tribasic acid.

A Compound of Orthotoluidine and Copper Bichloride.—E. Pomey.—This compound is not analogous in composition to the compound of cupric trichloride and paratoluidine, which the author has recently described. Both the copper and the chlorine are completely precipitable in their aqueous solution, the former by potassa and the latter by silver nitrate. This compound contains 5 mols. of orthotoluidine hydrochlorate to 1 of cupric chloride, whilst the para-compound contains only 2 mols.

Di-isobutylamine Hydrochlorate and Chloroplatinate, and on Tri-isobutylamine Chloroplatinate.—H. Malbot.—The di- and tri-isobutylamine chloroplatinates are respectively very distinct in figure, grouping, colour, lustre, crystalline system, cleavage, solubility, and deliquescence.

On Gluconic Acid.—L. Bourtroux.—The author points out that he obtained crystalline ammonium gluconate in 1880, and described it in the *Comptes Rendus* (xci., p. 236), and more in detail in the *Annales de l'Ecole Normale* (series 2, vol. x., p. 112). Herr Franz Volpert has, however, announced it as a novelty in the *Berichte der Deutsch. Chem. Gesell.* (October, 1886, p. 2621).

Characters of Olive Oils.—Albert Levallois.—The most constant characteristic of pure olive oil is its specific gravity, by which it may be distinguished from all the common oils except those of colza and of earth-nuts, which are easily distinguished by other characters. The action of bromine upon the fatty acids, when set at liberty, distinguishes olive oil very clearly from all the common oils except that of earth-nuts.

MISCELLANEOUS.

Action of certain Non-Metallic Elements upon Solutions of Silver and Copper Nitrates.—J. B. Senderens.—The action of sulphur upon solutions of silver nitrate has been studied by the author and M. Filhol. It produces silver sulphide and free nitric and sulphuric acids. At 100° the reaction is complete only in very dilute solutions, and takes place very slowly. At common temperatures it requires some months for completion. With pulverised selenium the reaction is more rapid, the products being silver selenide and selenious acid. With tellurium the result is similar, but rather less rapid. Sulphur and selenium do not act upon solutions of copper nitrate, but tellurium reduces them partially with the aid of heat. Phosphorus and arsenic form with solutions of copper nitrate two compounds not yet described, a phosphide, Cu_5P_2, and an arsenide of a corresponding composition.—*Comptes Rendus.*

MEETINGS FOR THE WEEK.

MONDAY, 14th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 15th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8. "The Application of Gems to the Art of the Goldsmith," by Alfred Phillips.
WEDNESDAY, 16th.—Society of Arts, 8. "Machinery and Appliances Used on the Stage," by Percy Fitzgerald.
—— Meteorological, 7.
THURSDAY, 17th.—Royal, 4.30.
—— Royal Institution, 3. "The Science of Thought," by Prof. F. Max Müller, M.A., LL.D.
—— Chemical, 8. Ballot for the Election of Fellows. "On the Supersaturation of Salt Solutions," by W. W. Nicol.
—— London Institution, 6.
FRIDAY, 18th.—Royal Institution, 9. "Mental Differences between Men and Women" by G. J. Romanes, M.A., F.R.S.
SATURDAY, 19th.—Royal Institution, 3. "Sound," by the Right Hon. Lord Rayleigh.

TO CORRESPONDENTS.

Cassius.—If possible do not let the paper occupy more than a page. The one just received is much longer than we like to insert.

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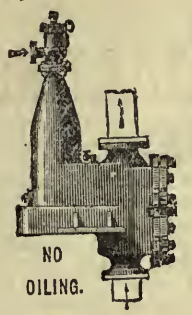

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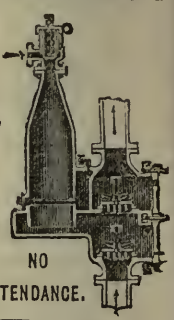

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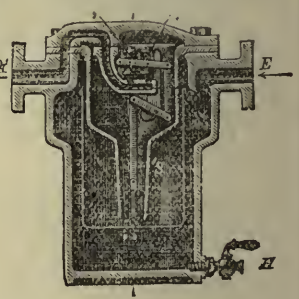

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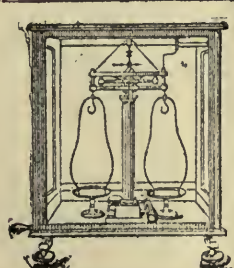

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THE CHEMICAL NEWS.

Vol. LV. No. 1425.

ON RADIANT MATTER SPECTROSCOPY:—EXAMINATION OF THE RESIDUAL GLOW.*

By WILLIAM CROOKES, F.R.S. V.P.C.S.

(Continued from p. 110).

In the search for bodies giving discontinuous phosphorescent spectra I have submitted a great number of earths and combinations to the electric discharge in vacuo, and have noted the results. As the superficial phosphorescence apart from the composition of the emitted light has formed the subject of several recent papers by my friend M. Lecoq de Boisbaudran, before the *Académie des Sciences*, it may be useful if I place on record some of the more striking facts which have thus come under my notice. The bodies are arranged alphabetically, and, unless otherwise explained, were tested in the radiant matter tube in the form of ignited sulphates.

Alumina, in any of the forms which give the crimson line (λ6942—6937) has a very persistent residual glow. In the phosphoroscope rubies shine with great brilliancy. This phosphorescence of alumina has recently been the subject of a paper read before the Royal Society.†

Antimony oxide with 95 per cent of lime (in the form of ignited sulphate). White phosphorescence, the spectrum showing a broad space in the yellow, cutting the red and orange off. In the phosphoroscope the residual glow is very strong, and of a greenish colour. The spectrum of the residual light shows that the red and orange are entirely obliterated, leaving the green and blue very luminous. Antimony oxide with 99 per cent of lime gives a pale yellowish phosphorescence, which on heating turns red. In other respects it is like the 5 per cent mixture.

Arsenious acid with 99 per cent of lime gives a greenish white phosphorescence like pure calcium sulphate.

Barium 5 per cent, *calcium* 95 per cent.—The sulphates phosphoresce green, with specks of yellow and violet. The spectrum is continuous, with slight concentration in the red, great concentration in the green, and in the orange a broad black band hazy at the edges.

Bismuth 15 per cent, *calcium* 85 per cent, phosphoresces of a bright reddish orange. The spectrum shows a tolerably sharp and broad dark band in the red and orange, and a strong concentration of light in the green and blue; the spectrum being continuous and divided into two parts by a black band in the yellow, as in the case of the antimony-calcium spectrum. In the phosphoroscope the red and orange disappear and the green and blue remain. Bismuth 7 per cent, calcium 93 per cent.—The action is similar to the 15 per cent mixture, except the colour of the phosphorescence, which is whiter. In the phosphoroscope the red and orange below the dark band is cut off. With 2 per cent of bismuth the same phenomena occur. With 0·5 bismuth the phosphorescence is greenish blue and the spectrum is continuous, with strong concentrations in the orange and green. The phosphoroscope cuts off the red and orange.

Cadmium 1 per cent, *calcium* 99 per cent.—Similar to calcium sulphate, *q. v.*

Calcium sulphate was prepared from a colourless and transparent rhomb of Iceland spar which had been used for optical purposes. It was dissolved in nitric acid, the nitrate was decomposed with distilled sulphuric acid, and the ignited sulphate tested in the tube. The phosphorescence is bright greenish blue without bands or lines. In the phosphoroscope the colour is a rich green; the spectrum shows the red and orange entirely cut off, leaving the green and blue; the blue is especially strong.

Calcium sulphates prepared from Professor Breithaupt's calcites* were re-examined. All phosphoresce with the normal greenish blue glow of calcium, except No. 11, which gives a reddish glow. A minute trace of samarium was found in this calcite, but not enough to affect the colour of the glow. In the phosphoroscope all the specimens give a continuous spectrum beyond the yellow, the red and orange being cut off as usual.

Chromium 5 per cent, *calcium* 95 per cent, as sulphates, gives a pale reddish phosphorescence. In the phosphoroscope the colour is green and the red and orange are cut off. One per cent of chromium with calcium phosphoresces green in the cold, and becomes red when slightly heated. The behaviour of chromium with aluminium has already been described.†

Copper sulphate with 95 per cent calcium sulphate behaves like calcium sulphate.

Diamonds phosphoresce of various colours. Those glowing pale blue have the longest residual glow, next come those phosphorescing yellow: I am unable to detect any residual glow in diamonds phosphorescing of a reddish colour. A large diamond of a greenish hue, very phosphorescent, shines almost as brightly in the phosphoroscope as out of it.

Glucina phosphoresces of a rich blue colour. There appears to be no residual glow with this earth in the phosphoroscope.

Lanthanum.—All the specimens of lanthanum sulphate I have examined in the radiant-matter tube phosphoresce of a reddish colour, and give a broad hazy band in the orange, with a sharp line—$\frac{1}{\lambda^8}$ 280—superposed on it. This is identical with the line of Gε, one of the constituents of the samarium phosphorescent spectrum. Calcium added to lanthanum changes the colour of the phosphorescence from red to yellowish, and brings out yttrium and samarium lines, these metals being present as impurities; the Gδ and Gα lines are also seen, but the space which should be occupied by the Gβ green is now a dark space. I have shown that when Gδ, Gα, and Gβ are present in very small quantities with lime, the lines of Gδ and Gα are intensified, while that of Gβ is weakened. This new result seems to show that if only a small trace of Gβ is present with lime and lanthanum, the green line is not only suppressed, but the quenching action has actually extended so far as to neutralise that part of the continuous lime spectrum having the same refrangibility as the Gβ line, the result being a black space in the spectrum. In the phosphoroscope the line of Gε is visible at the slowest speed; Gδ comes in at an interval of 0·0035 second, and the Gα line immediately afterwards.

Lead sulphate, by itself, in the radiant-matter tube glows with a nearly white colour, giving a continuous spectrum. In the phosphoroscope the red and orange are cut off, leaving a strong concentration of light in the green and blue. Five per cent of lead added to calcium sulphate phosphoresces like lime.

Magnesia phosphoresces pink. Five per cent with lime, as sulphates, give a greenish phosphorescence, with a tendency to turn red as the powder heats. The Oriental ruby containing about between 1 and 2 per cent of magnesia, a mixture was prepared of acetate of alumina with 2 per cent of magnesia, and tested after ignition. It gave no spectrum or lines. This was done to see if the crimson line of aluminium might be due to the presence of magnesia.

Nickel added to calcium sulphate in the proportion of 5 per cent makes no alteration in the usual phosphorescent phenomena of calcium.

Potassium 5 per cent, added to calcium sulphate gives

* A Paper read before the Royal Society, Feb. 17, 1887.
† *Roy. Soc. Proc.*, 1887, vol. xlii., p. 25.

* *Phil. Trans.*, 1885, Part 2, p. 697.
† *Roy. Soc. Proc.*, 1887, vol. xlii., p. 28, *et seq.*

a bright phosphorescence and made the residual glow very persistent.

Samarium.—The phosphorescent behaviour of this body, alone and mixed with other substances, has been fully described in my paper on samarium.*

Scandium, either in the form of earth or sulphate, phosphoresces of a very faint blue colour, but the light is too feeble to enable a spectrum to be seen. Addition of lime does not bring out any lines.

Sodium sulphate mixed with an excess of calcium sulphate gives a greenish tinge to the usual colour of the phosphorescence. The sodium line is visible in the spectrum.

Strontia in the radiant-matter tube glows with a rich blue colour, showing in the spectroscope a continuous spectrum with a great concentration of light in the blue and violet. In the phosphoroscope the colour of the glow is bright green, showing in the spectroscope a continuous spectrum, with the red and blue ends cut off. A mixture of calcium sulphate with 5 per cent of strontium sulphate behaves like calcium sulphate alone.

Thorium, as oxide or sulphate, refuses to phosphoresce, and the tube rapidly becomes non-conducting. A tube with thoria at one end and a phosphorescent earth such as lime or yttria at the other end, and furnished with a pair of poles near each end, at a particular exhaustion is non-conducting at the thoria end, while it conducts at the yttria end. If the wires of the induction coil are attached to the poles at the thoria end, no current will pass; rather than pass through the tube, the spark prefers to strike across the spark-gauge — a striking distance of 37 millimetres — showing an electromotive force of 34,040 volts. Without doing anything to affect the degree of exhaustion, on transferring the wires of the induction coil from the thoria to the yttria end, the spark passes at once. To balance the spark in air the wires of the gauge must be made to approach till they are only 7 millimetres apart, equivalent to an electromotive force of 6440 volts; the fact of whether thoria or yttria is under the poles making a difference of 27,600 volts in the conductivity of the tube. The explanation of this action of thoria is not yet quite clear. From the great difference in the phosphorescence of the two earths, it is evident that the passage of the electricity through these tubes is not so much dependent on the degree of exhaustion as upon the phosphorogenic property of the body opposite the poles. This view is supported by the fact that the thoria may be replaced by a metal wire, when the same obstructive action will result.

Lime does not give phosphorescent properties to thoria, if this earth be pure, but it brings out the lines of yttrium and samarium which are almost always present in small quantities in thoria unless it has been specially purified.

Tin with 95 per cent of lime gives the lime phosphorescence only.

Thulium and *erbium* together phosphoresce with a green light, giving the erbium spectrum already described before this Society.† There is, in addition, a faint blue line, apparently double (see "Ytterbium"). The addition of lime causes the mixture to phosphoresce of a pale blue colour. The spectrum now shows a bright blue band, in the same position as the faint double blue band seen in the absence of lime. The blue line of Gα is also seen, and a faint line of Gδ. The deep red line of Gη, one of the constituents of the ordinary yttria spectrum, is prominent in this spectrum.

Tungsten and *uranium*, each mixed with 95 per cent of lime, only give the lime spectrum.

Ytterbium.—I have not yet succeeded in preparing this body of trustworthy purity; but through the kindness of Prof. Clève, M. de Marignac, and Prof. Nillson I have been enabled to experiment with specimens of ytterbia prepared by these chemists. Prof. Clève's ytterbia, in the form of sulphate, gives in the radiant-matter tube a blue phosphorescence, the spectrum of which shows a strong double blue band,* together with traces of the Gδ and the erbia green lines. The addition of lime broadens the blue band and makes it single. Prof. Clève writes that this ytterbia may contain some traces of thulia, perhaps also of erbia, but scarcely any other impurities. Measurements in the spectroscope give the following approximate results.

Scale of Spectroscope.	λ	$\frac{1}{\lambda^2}$	Remarks.
8·63	4626	4673	Commencement of first blue line. This edge is very hazy.
8·54	4574	4780	Centre of the first blue line.
8·45	4524	4885	End of first blue line.
8·44	4518	4898	Centre of dark interval between the two blue lines.
8·40	4475	4994	Centre of second blue line. This line is narrower than the first line.

The following are measurements taken with the mixture of this ytterbia and lime:—

8·71	4674	4577	Up to this point there is the continuous spectrum of li-calcium. Here a black space commences.
8·515	4555	4819	Commencement of a hazy blue band.
8·475	4538	4855	End of hazy blue band. This band is of considerable brilliancy.

These blue bands are seen much fainter without lime, and are about as strong in the mixture of thulia and erbia with lime described above. I had ascribed them to ytterbia, when Professor Nillson kindly forwarded me a small specimen of ytterbia, considered by him perfectly pure, and used for his atomic weight determinations. This ytterbia gives absolutely no blue bands. The origin of these bands therefore remains uncertain.

Ytterbia from Professor Nillson, in the form of sulphate, refuses to phosphoresce without the addition of lime. When lime is added it only brings out traces of the phosphorescent bands of Gε, Gβ, and Gα. Evidently these are impurities.

Ytterbia from M. de Marignac is identical with that from M. Clève, as far as my examination can go. In sending me this ytterbia M. de Marignac warned me that he was very far from thinking it pure.

Yttrium.—During the fractionation of the higher fractions of yttria (+6, 118 and 119), a very sharp green line sometimes makes its appearance, situated between Gβ and Gγ (approximate position on the $\frac{1}{\lambda^2}$ scale, 325). It is very faint, and is not connected with the orange line of Sδ, although it is as sharp. The yttria showing these lines phosphoresces of a transparent golden yellow colour, the fractions at the other end phosphorescing yellowish green.

I have previously described the action of a large number of bodies on the phosphorescence of samarium.† The experiments resulting in the following observations were tried at about the same time. I will describe them in alphabetical order. Unless otherwise mentioned all the mixtures were in the form of anhydrous sulphates.

Yttrium 5 per cent, *aluminium* 95 per cent, gives a good yttria spectrum; the blue line of Gα is very distinct, and the double green of Gβ is well divided. In the phosphoroscope the Gβ and Gα lines first appear simultaneously, then the Gδ line.

* *Phil. Trans.*, 1885, Part 2, pp. 709—721.
† *Roy. Soc. Proc.* vol. xl., p. 77, fig. 1, Jan. 7, 1886.

* This is the band spoken of in my Royal Society paper of June 9th last (*Roy Soc. Proc.*, 1886, vol xl., p. 507), provisionally called Sγ and ascribed to ytterbia. If it is not due to ytterbia it is a new body
† "On Radiant Matter Spectroscopy. Part 2—Samarium." *Phil Trans.*, 1885, Part 2, pp. 710—722.

Yttrium 99·5 per cent, *bismuth* 0·5 per cent.—The spectrum is bright, and on close examination a trace of samarium green, Gγ, is to be detected forming a wing to the Gδ line. In the phosphoroscope the citron line of Gδ entirely disappears and the samarium double green line, which out of the phosphoroscope is almost obscured by the great brightness of Gδ, now appears distinctly, together with the green Gβ line. Yttrium 95 per cent, bismuth 5 per cent, gives the usual yttria spectrum. No Gδ line appears in the phosphoroscope at any speed. At first only the Gβ line is seen, and next the Gα line appears, as in yttria. On gradually increasing the percentage of bismuth the spectrum of yttria grows fainter, until with 95 per cent of bismuth the phosphorescence is bad and the spectrum faint.

Yttrium 5 per cent, *cadmium* 95 per cent, gives a brilliant phosphorescence, but the spectrum is almost continuous. In the phosphoroscope a faint concentration of light is seen in the green, which becomes sharper as the speed increases.

The action of calcium on the phosphorescence of yttrium has already been described.

Yttrium and *Cerium*.—Cerium has the effect of deadening the brilliancy of the yttrium spectrum in proportion to the quantity added. All the bands remain of their normal sharpness.

Yttrium 5 per cent, *copper* 95 per cent, phosphoresces very feebly.

Yttrium 90 per cent, *didymium* 10 per cent.—This mixture gives a good yttria spectrum. Yttrium 70 per cent, didymium 30 per cent, phosphoresces very fairly and gives all the usual lines.

Yttrium 50 per cent, *didymium* 50 per cent, refuses to phosphoresce. The tube is either too full of gas to allow the phosphorescence to be seen or it becomes non-conducting. When the mixture is illuminated by the glowing gas the absorption lines of didymium in the green are seen. With higher proportions of didymium the same results are produced. On adding 25 per cent of lime to the mixture containing 50 per cent of didymium the yttria spectrum is brought out very well. Lime added to a mixture of 10 per cent yttria and 90 per cent didymium brings out the yttrium spectrum fairly, but the tube soon becomes non-conducting.

Yttrium 5 per cent and *glucinum* 95 per cent gives a bright phosphorescence, but the definition of the spectrum lines of yttria is bad.

Yttrium 5 per cent, *thallium* 95 per cent.—No spectrum is given by this mixture, it turns black and refuses to phosphoresce.

Yttrium 5 per cent, *tin* 95 per cent, phosphoresces faintly, the lines being very indistinct.

Yttrium 5 per cent, *titanium* 95 per cent, acts like thoria, and the tube becomes non-conducting.

Yttrium 5 per cent, *tungsten* 95 per cent.— This phosphoresces of a bright yellow colour, the spectrum is brilliant, but the lines are not sharply defined. In the phosphoroscope the colour becomes greenish, and the spectrum shows only the green lines of Gβ.

Yttrium 5 per cent, *zinc* 95 per cent. — The phosphorescence is of a pale yellowish white, and the spectrum is very brilliant, being equal to that shown by 30 per cent of yttrium with barium, calcium, magnesium, or strontium. In the phosphoroscope the colour becomes reddish and the Gβ green line is the first to come. No citron line is seen. If the yttrium contains a trace of samarium, the samarium spectrum, which is scarcely seen under ordinary circumstances, now comes out distinctly.

Zinc sulphate mixed with 95 per cent of calcium sulphate phosphoresces a bright bluish-green colour; the spectrum contains no bands or lines.

Zinc sulphide (Sidot's hexagonal blende*).—This is the most brilliantly phosphorescent body I have yet met with. In the vacuum tube it begins to phosphoresce at an exhaustion of several inches below a vacuum. At first only a green glow can be seen; as the exhaustion gets better a little blue phosphorescence comes round the edges. At a high exhaustion, on passing the current the green and blue glows are about equal in brightness, but the blue glow vanishes immediateiy the current stops, while the green glow lasts for an hour or more. In the phosphoroscope the blue glow is only seen at a very high speed, but the green glow is seen at the slowest speed, and the body is almost as bright in the instrument as out of it. Some parts of a crystalline mass of blende which, under the action of radiant matter, leave a glow with a bright blue colour, leave a green residual light when the current ceases; other parts which glow blue become instantly dark on stopping the current.

(To be continued).

* *Comptes Rendus*, lxii., 1866 pp. 999—1001 lxiii. 1866 pp. 188—189.

THE DETERMINATION OF THE TOTAL ORGANIC CARBON AND NITROGEN IN WATERS BY MEANS OF STANDARD SOLUTIONS.*

By CHARLES A. BURGHARDT, Ph.D.

THE Members of this Society may remember that I read before them a preliminary note on a method for rapidly determining the total organic carbon in waters, on the 23rd of February, of this year. The communication I make to-day must also be considered as a "preliminary note," because the method of analysis applied in this case is entirely distinct from that given in my first communication, and I wish to collect all the material I can before venturing to criticise fully the work of other chemists in regard to the analysis of waters.

I have during the last six months had many excellent opportunities for thoroughly testing the working of the chromic acid method for the determination of organic carbon in waters of various qualities, and am perfectly certain that the results are eminently satisfactory so far as the *complete* estimation of the organic carbon is concerned. I wished, however, to estimate in an easy and accurate manner the total amount of organic nitrogen, and also to make the determination of the organic carbon simpler and less complicated. There is no doubt at all in my mind, in the case of a sewage-polluted stream or well, that the determination of the carbonic acid gas given off (after driving off the free dissolved carbonic acid gas at 94° C.) on heating the water to 100° C. is a most valuable portion of water examination, because *that particular carbonic acid gas* has been formed entirely *from organic matters in a partially decomposed or putrescent condition.* This organic matter is entirely lost in the course of evaporation as required by the "combustion process," and it certainly constitutes a large proportion of the total organic matter present in a sewage-polluted water,—a fact which has been proved by my analyses of the Irwell water, and experiments made with it. I find that Prof. J. W. Mallet, F.R.S., of the University of Virginia, mentions (in his Report to the National Board of Health, Washington, 1880) the source of error: he says—"As regards the combustion process we find distinct confirmation of the existence of the two forms of constant error which have been pointed out as affecting the Corporation. The weaker the solution—or, in other words, the larger the quantity of water to be evaporated for a given amount of organic matter—the less is the amount of organic carbon contained, indicating relatively greater loss of this element. On the contrary, the weaker the solution, or the greater the quantity of water to be evaporated, the larger is the figure for organic nitrogen,

* A Paper read before the Manchester Literary and Philosophica Society, December 14th 1886.

indicating relatively greater gain of this element from the atmosphere."

I conclude, therefore, that in many cases it will be necessary to determine the carbon *corresponding to the organic matter volatile* at 100° C. in the manner I point out in my previous paper on the subject.

As one proof out of many which I could lay before you I will give an analysis made by the "ammonia process," the "permanganate process," and the "chromic acid process," the sample being one taken from the Irwell at Throstlenest, on the 19th of February, 1886, and the results are expressed in grains per gallon:—

(1) Free ammonia .. .. 0·196.
Albumenoid ammonia . 0·226.

(2) Oxygen required to oxidise the organic matter:—

In three minutes.	One hour.	Three hours.
0·413	1·442	1·694.

(3) Carbonic acid given off on heating to 96° C. = 1·512.
,, ,, ,, 100° C. = 7·224.
Carbonic acid estimated separately by precipitation with ammoniacal barium chloride solution (therefore as carbonates) .. = 2·681.
Carbonic acid obtained by oxidation by means of chromic acid .. .. = 2·733.

As the water was carefully heated to a temperature not exceeding 96° C., until all the *dissolved free* carbonic acid was liberated and no more was given off, it is clear from these results that the carbon of the 7·224 grains of carbonic acid gas given off on boiling the water (1·9701 grains) was derived from organic matter undergoing rapid decomposition at 100° C., *and from no other source.*

I venture to think that a result of this kind shows the necessity of devising a method for the accurate determination of the carbon in the water itself, and not by burning the residue obtained on its evaporation, and then measuring the amount of carbonic acid gas thus obtained.

On comparing the total carbon obtained by my process (calculated from the two amounts of carbonic acid gas, viz., 7·224+2·733=9·057 CO_2=2·667 carbon), with the amount of carbon corresponding to the amount of oxygen required to oxidise it in three hours, viz., 2·329 grains of carbon, it is evident that there is a loss of 14·51 per cent of the carbon in the permanganate process, or, in other words, *that* process in this particular instance failed to estimate the amount of carbon present by 14·51 per cent. I have found, however, in some cases that it expresses fairly well the amount of organic carbon present in a water, but it cannot be safely relied upon to do so.

I will pass from this part of the subject to the modification of my process which I have arrived at after considerable experiment and expenditure of time.

The principle of my first process consisted in the oxidation of the carbon in the water to carbon dioxide, this being effected at the expense of the chromic acid, consequently the latter must be reduced to a lower oxide of chromium during the process. Bearing this fact in mind I at last concluded that a determination of the amount of oxygen given off by the chromic acid to the carbon must necessarily give me the equivalent to it of carbon in the water. The reaction which occurs on adding a solution of chromic acid in water (acidulates with sulphuric acid) to water containing organic matter is as follows, viz.:—

$$4CrO_3+6SO_4H_2+3C=3CO_2+2Cr_2(SO_4)_3+6H_2O.$$

As an excess of chromic acid is always used in the process, all that is therefore necessary is to estimate the amount of chromic acid still remaining unreduced, by means of some convenient standard solution, which is itself oxidised by the excess of chromic acid. In order to carry out the process I first prepare the necessary standard solutions.

Preparation of the Standard Solutions.

1st. Ordinary decinormal permanganate of potassium solution (3·16 grms. to 1 litre).

2nd. A solution of pure chromic acid in pure distilled water (about 10 grms. to the litre).

3rd. A solution of ferrous sulphate in pure distilled water (about 25 grms. to the litre).

First I titrate the ferrous sulphate solution by means of the decinormal permanganate solution, and find in this way how much permanganate is equal to the ferrous sulphate solution, and, knowing the "oxygen value" of the permaganate solution, it at once furnishes me with the "oxygen value" of the ferrous sulphate solution.

Next I take a known volume of the chromic acid solution and titrate it with the standard ferrous sulphate solution, until all the chromic acid is reduced, a point easily seen with a little practice, as the slightly yellowish green colour at the final stage of the titration changes sharply to a bluish green on the addition of *one* drop, and one further; at this point using a solution of ferricyanide of potassium as an indicator, it is seen that there is a very slight indication of excess of ferrous sulphate present, whereas, before the addition of this drop, there was no such indication. This operation furnishes the value of the chromic acid solution *expressed as ferrous sulphate solution.*

The chromic acid solution will keep a very long time, but it is advisable to prepare the ferrous sulphate solution freshly at least once a week.

Having prepared the standard solutions the process of analysis is as follows, viz.:—

Determination of the Organic Carbon.

Place 250 c.c. of the water sample in the "boiling flask," of 16 oz. capacity, add 100 c.c. of the chromic acid solution, and 10 c.c. of strong sulphuric acid, and boil for about thirty minutes, when the oxidation of the organic matter is complete, the water in the "boiling-flask" having become perfectly clear. I then dilute the contents of the flask to 1 litre, and take out 100 c.c. of this solution and titrate it with the standard ferrous sulphate solution until there is a very slight excess of the latter. By calculation I find how much *carbon* the *oxygen* thus indicated is equal to.

Determination of the Organic Nitrogen.

Contrary to expectation I found that the nitrogen in organic compounds is converted into ammonia and not into nitric acid or nitrous acid by the action of chromic acid or sulphuric acid. A similar fact was discovered by Kjeldahl (*Zeits. Anal. Chem.*, xxii., 366), where he describes the conversion into ammonia of nitrogenous matter, by boiling it with strong sulphuric acid, phosphorus pentoxide, and powdered manganate of potassium.

Märker tested this method thoroughly (*Zeits. Anal. Chem.*, xxiii., 553—557) against the well-known method of Varrentrapp and Will, and found the results by Kjeldahl's method sufficiently correct.

To determine the organic nitrogen in the water I take 250 c.c. or more of the solution obtained by the previous organic carbon process (the solution made up to 1 litre), place it in the "boiling-flask," pour down the funnel tube a perfectly ammonia-free caustic soda solution *in excess*, and attach the exit-tube of the "boiling-flask," to the Liebig's condenser and flask as used in the organic carbon determination, placing, however, in this case, about 50 c.c. of ammonia-free water and a few drops of pure hydrochloric acid into the "receiving-flask." It is also better to take the necessary precautions to prevent the sucking of the water in the "receiving-flask," back into the "boiling flask." I boil the contents of the flask for about thirty minutes (keeping the condenser cool), then I make up the condensed water in the "receiving-flask" to one litre, take out 100 c.c., and determine the amount of ammonia present in it in the usual way with Nessler's reagent, and calculate how much nitrogen it corresponds to.

I do not lose any nitrogen by this method, because all the ammonia evolved from the "boiling-flask" is passed

into cold acidulated water, whereas by the old "ammonia-method," the violent bumping in the retort often drives steam, and no doubt ammonia, right through the long condensers used in that process, consequently there must be a loss of ammonia.

I have not yet had sufficient time to work out by my method the limits at which a water can be said to be *unsafe* to drink, but I hope to do so shortly.

Example of Analysis of Sewage Water from Devizes.

(1) *Ammonia Process.*

Contains free ammonia .. .. 0·560 grains per gallon.
,, albumenoid ammonia:—
1st distillate.. .. 1·435 ,,
2nd distillate .. 0·420 ,,
Total ammonia .. 2·415
= nitrogen 1·988 grains per gallon.

The albumenoid ammonia in the first distillate was obtained by distilling in the usual way until no more ammonia could be estimated by Nessler's reagent. The retort and apparatus was then carefully closed for the night, and the contents distilled again next morning, the result being a second crop of ammonia (distillate No. 2).

(2) *Oxygen Process.*

Oxygen required to oxidise organic matter, in grains per gallon.

In three minutes.	One hour.	Three hours.
1·862	3·472	5·48.

5·48 grains of O = 4·11 grains of C.

(3) *Chromic Acid Process.*

(*a*) by titration with ferrous sulphate.

250 c.c. of sample taken, added 20 c.c. of the chromic acid solution, and 10 c.c. of strong sulphuric acid, and boiled for thirty minutes, diluted to 1 litre, and took 100 c.c. of this solution with the standard ferrous sulphate solution; required 19·0 c.c. of $FeSO_4$, therefore the whole litre would require 190 c.c. $FeSO_4$.

20 c.c. of the chromic acid solution required, on being titrated, 210·0 c.c. of the ferrous sulphate solution.

210 − 190 = 20 c.c. of $FeSO_4$ (equal to the chromic acid reduced by the carbon in the water).

Strength of the $FeSO_4$ Solution.

3·6 c.c. $FeSO_4$ = 100 c.c. of permanganate solution (5 c.c. permanganate solution = 0·0004 oxygen).

3·6 c.c. $FeSO_4 = 0{\cdot}0004 \times 20 = 0{\cdot}008$ oxygen.

$$20 \text{ c.c. } ,, = \frac{0{\cdot}0008 \times 20}{3{\cdot}60} = 0{\cdot}004444 \text{ \&c. oxygen.}$$

or 9·3824 grains of carbon per gallon.

(*b*) By the lime-water method and distillation.

50 c.c. lime-water = 50 c.c. standard oxalic acid.
1 c.c. oxalic acid solution = 0·001 CO_2.

250 c.c. of the Devizes sewage-water taken.

Took 200 c.c. lime-water altogether and titrated back with 72 c.c. oxalic acid solution.

128 c.c. of lime-water used.
128 c.c. = 0·128 CO_2.
= 9·72 grains of carbon per gallon.

This contained a little carbon present as carbonate.

Sale, Cheshire, Sample of Sewage Water.

Chromic Acid Process.

By lime-water method .. 0·1444 grain C.
By $FeSO_4$.. .. .. .. 0·1487 ,,

University of London.—We are requested to call attention to the change which it has been necessary to make in the time of holding the ensuing Matriculation Examination (viz., from the week commencing Monday, June 20th, to the preceding week, commencing Monday, June 13th).

ON THE

PHOSPHORESCENCE OF CALCIUM SULPHIDE.

By M. EDMOND BECQUEREL.

In the last number of the *Comptes Rendus* is a paper by M. Verneuil entitled "The Determining Causes of the Phosphorescence of Calcium Sulphide," containing the results of very interesting experiments, which in M. Verneuil's opinion confirm the views put forward by the author on the influence of foreign matters in modifying the molecular condition of phosphorescent calcium sulphide. He believes that it is interesting to recapitulate some of the inducements which have led him to think that the modifications undergone by this compound may depend on a change of physical condition.

Calcium sulphide, in fact, like most of the calcium compounds, is phosphorescent, but it presents differences according to its preparation, according to the duration, the intensity, and the refrangibility of the luminous rays emitted. Even when no notable effect is manifested on exposing it to light and placing it afterwards in a dark chamber, it gives a luminous emission in the phosphoroscope. Pure calcium sulphide, which M. Verneuil has prepared, and of which he has kindly forwarded two specimens to the author, behaves in this respect like the sulphides which the latter had prepared previously; it is faintly luminous in the phosphoroscope when it receives the action of the solar rays.

But the duration of the phosphorescence of this substance may be much increased by the presence of foreign matters added to the mass on its preparation, even though they may be very slightly or not at all phosphorescent; at the same time the luminous intensity is heightened, and the colour of the rays emitted is modified. This follows from observations which the author has made long ago, and which he is still pursuing. According to these calcium phosphide prepared from the lime of Iceland spar, arragonite, or other sources,—or with calcium carbonate, with which different bodies were mixed, especially metallic sulphides, potassium or sodium salts (potassium persulphide, sodium chloride, thiosulphate, &c.),—yields artificial phosphori, very persistent, more or less brilliant and luminous with different colours. He mentions the effects produced by traces of potassium persulphide and manganese peroxide. The former yields a very luminous matter with green phosphorescence; with manganese peroxide the phosphorescence is orange-yellow. The addition of lithium carbonate to the lime in the preparation of the sulphide yields, according to Dr. Strohl's observation, a substance having a very brilliant green phosphorescence of a peculiar shade. It must be observed that potassium, manganese, and lithium sulphides are scarcely luminous, or not at all.

The temporary modifications which certain phosphorescent preparations may undergo by the action of heat likewise support the hypothesis which ascribes the different shades given by different preparations of a phosphorescent sulphide to the varied physical states of such sulphide. Thus one of the calcium sulphides—which at ordinary temperatures, and prepared under the conditions which the author has formerly indicated ("La Lumière," vol. i., p. 389), gives out a green light—has a blue phosphorescence at 100° and a brilliant violet-blue between 200° and 300°. But at ordinary temperatures it recovers its green phosphorescence. It thus becomes temporarily capable of emitting, when heated, and after the previous action of luminous radiation, rays of the same refrangibility as those emitted permanently at common temperatures by a sulphide prepared in another manner.

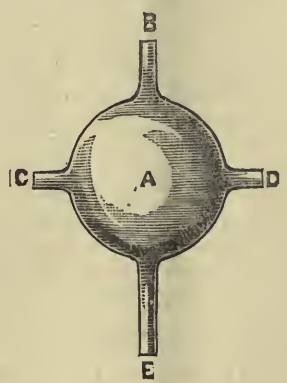
From the temporary influence of a temperature, not very elevated, not capable of decomposing the sulphide, and producing merely a change in the physical condition of the body, we may infer that effects of the same order may be produced permanently in the preparation of calcium sulphide by other processes.

Another phosphorescent substance, strontium sulphide, prepared with caustic strontia and sulphur, presents changes still greater, since after exposure to light it emits a violet-blue phosphorescence at −20°; at +40° it becomes light blue, at 90° greenish yellow, and at 150° orange, resuming at each temperature the corresponding luminous power. Thus this sulphide, taken at different temperatures, reproduces after insolation temporarily and successively almost all the prismatic colours, and consequently all the effects obtained permanently at common temperatures with different preparations of strontium sulphide.—*Comptes Rendus* (civ., p. 551).

METHOD OF PREPARING GRAPHITOIDAL CARBON FOR ELECTRICAL INCANDESCENCE.

By H. N. WARREN, Research Analyst, &c.

HAVING recently had occasion to pass a series of electrical sparks over certain substances in a current of hydrogen gas, for the sake of simplifying the arrangement I substituted for the hydrogen coal-gas, and on observing after the lapse of a short time a somewhat small but dense black point projecting from the negative wire. I at once stopped the experiment with a view of ascertaining the cause of the above phenomenon, and finding it to consist entirely of graphitoidal carbon. I made use of the following apparatus, consisting of a glass globe, A, con-



taining four openings or necks. The coal-gas being admitted at the tube E, and consumed at B; at C and D are two platinum wires, the one at D being somewhat the longer, so as to allow of its gradual withdrawal through the cork inserted in the neck D. The extremities of both wires were connected respectively with an induction coil capable of giving an intense half-inch spark. After an interval of a few minutes a blackish point was observed projecting from the negative wire, and nearly touching the positive. On withdrawing the latter a slight distance from the negative, the graphite stem (so to call it) lengthened itself as before towards the positive pole, and in so doing doubled its original length; and on repeating the former operation of partially withdrawing the positive wire, a continuous line of graphitoidal carbon was obtained measuring from an inch to an inch and a half.

On being withdrawn from the apparatus it was found to consist, although fine as regards diameter, of very hard graphitoidal carbon, and exhibited when under the microscope a decided crystalline structure.

On being connected as before with the induction coil and suspended in an atmosphere of oxygen, on connection with the battery being made it was dissipated with great brilliancy, leaving no residue. A similar piece gave a most intense and durable light in vacuum.

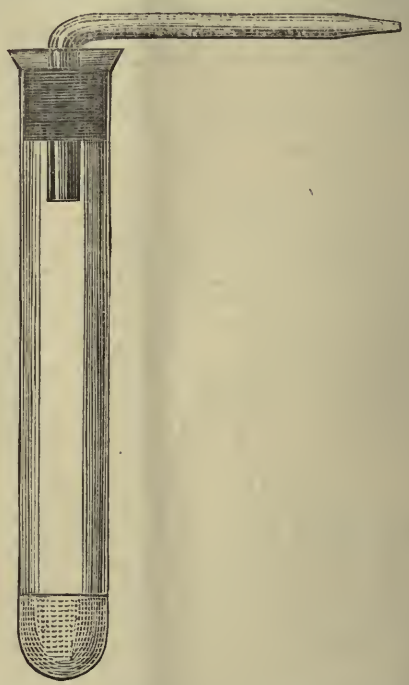
I have lately varied the experiment by introducing for electrolysis a mixture of coal-gas and silicon fluoride, as also boron fluoride, with the object of forming a still denser and more durable carbon in admixture with silicon or boron, but have hitherto only partially succeeded.

APPARATUS FOR THE EXAMINATION OF WATER BY DR. KOCH'S PROCESS.

By CHAS. W. FOLKARD.

THE necessity for special apparatus is always a drawback, and, in common with many others, the author has endeavoured to use the ordinary laboratory appliances alone in carrying on bacteriological examinations of water.

Test-tubes, about 7 inches long and ¾ inch in diameter, are used to receive the nutrient jelly. They are closed by a plug of cotton-wool, which is tied by thread round a piece of glass tube bent at right angles and drawn off at one end. The bent tube has a capacity of 1 c.c., and



serves for the introduction of the measured quantity of water for experiment. The whole is sterilised in the usual way.

The water, of which a sample is required to be examined, is allowed to run through a piece of ⅛ inch india-rubber tube (pierced with a small hole in the middle, and furnished with a glass jet at the end) till all germs on the tube have been washed away.

The capillary end, *a*, is passed through the hole in the india-rubber tube, and sufficient time allowed for any germs on it to be washed off. The capillary end is then broken off by the fingers, or by a pair of pliers, while it is inside the india-rubber tube.

The water (which is of course running all the time) fills the bent tube, being assisted if necessary by partially stopping the glass jet for an instant. The bent tube is then withdrawn, the capillary end sealed in the flame, and the 1 c.c. of water transferred to the test-tube by shaking.

By allowing the gelatin to set when the test-tube is in a horizontal position, the "centres" can be easily counted

and examined, being spread over an area of 4 or 5 square inches.

The above is merely a simplified form of the well-known Aitken's test-tube, enabling the operator to dispense with all but the ordinary laboratory apparatus. The transfer of the solution from the test-tube to a glass plate, with the attendant risk of aërial contamination, is also avoided.

The desirability of taking the tube to the water supply, instead of bringing a sample of water to the laboratory, is obvious, and in the majority of cases there is no great difficulty in doing so.

Chiswick, March 8, 1887.

ON NEW ZEALAND GRAPHITE.

By R. W. EMERSON McIVOR, F.I.C., F.C.S.

Large quantities of graphite exist at Pakawan Bay, in Golden Bay, N.Z., which will sooner or later be turned to commercial account. When in Nelson a year or two ago I was called upon by Mr. J. Gilmour, one of the lessees of the ground, to examine the material "as dug out of the ground." The following are my analyses of dried samples:—

	No. I.	No. II.
Carbon..	34·99	51·45
Ash	65·01	48·55
	100·00	100·00

No. II. appears to be as good in quality as much of the graphite sold for common purposes in this country.

RIDSDALE'S ROTARY CHROMOMETER.

Mr. C. H. Ridsdale, a short time since, in a paper to the Society of Chemical Industry,* in giving his experience on the estimation of very low percentages of carbon, stated that at the North-Eastern Steel Works at Middlesborough, where they constantly tested steels containing only from 0·02 to 0·05 per cent of this body, they had adopted Stead's alkali method as being rapid and very accurate, and he also described an apparatus for comparing the depths of tint of the very weak solutions obtained in this method.

In Stead's alkali method the steel is dissolved in nitric acid, and caustic soda added, which precipitates ferric hydrate and causes the combined carbon to pass into solution, and the liquid is then made up to a definite bulk, filtered, and the filtrate compared in the apparatus with a standard treated in the same way. The relative height of the column of liquid required to give equal depth of tint indicates the carbon content.

The apparatus is the outcome of long practical experience with this class of work, and is specially designed to avoid fracture, and for rapid and reliable work. It consists essentially of three comparison tubes, into one of which the solution to be tested is put; and in the other two, columns of standards of different strength can be raised or lowered by means of glass syringes. The apparatus can be revolved to overcome the influence of side light, and to obtain better comparison.

As the standards are pumped in and out of their reservoirs without taking to pieces at all, there is no liability to breakage as in previous chromometers.

The Æolus Waterspray Company have removed from No. 235 to No. 124, High Holborn, London, W.C.

* Read at Newcastle; published in the *Journal o the Society of Chemical Industry*, No. 11, vol. v.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, January 25th, 1887.

Prof. W. C. Williamson, LL.D., F.R.S., Vice-President, in the chair.

The following communication from the Secretary of the Manchester Jubilee Exhibition, addressed to the Honorary Secretaries of the Society, was read:—

The Photographic sub-section of the Jubilee Exhibition are devoting a portion of their space to a history of the rise and progress of the Photographic Art, and are anxious to hear of specimens or apparatus bearing upon this department of the subject. They will be obliged by possessors of any such objects of interest communicating with them at the offices, Albert Chambers, Albert Square, Manchester.

Professor W. C. Williamson, LL.D., F.R.S., brought before the Society the substance of a communication which he had received from James Nasmyth, Esq., of Penshurst. Experimenting upon the action upon glass of the coke used for heating the boilers of locomotives, Mr. Nasmyth found that a piece of hard coke "possesses the diamond property of cutting a clean diamond-like cut into glass, not a mere scratch, but a true cut through it." Mr. Nasmyth further points out that if this is done when the glass is held at a slight inclination to the direction of the sun-light showing through it, the cut thus made gleams with prismatic rays. These effects all correspond so closely with those produced when a diamond is similarly used, as to suggest that the coke bears some humble relationship with the diamond so far as glass-cutting is concerned.

Microscopical and Natural History Section.

Ordinary Meeting, January 17th, 1887.

Prof. W. C. Williamson, LL.D., F.R.S., Vice-President, in the chair.

Mr. R. T. Burnett, F.G.S., was elected an Associate of the Section.

Mr. Henry Hyde exhibited a leaf of *Bryophyllum calycinum*, with young plants growing out of the margin.

Dr. Alex. Hodgkinson read a paper "*On Cavities in Minerals containing Fluid, with Vacuoles in Motion, and other Inclosures.*"

It is matter of common observation that salts in crystallising from their solutions frequently shut off spaces containing portions of the fluid. If at the time of crystallisation the temperature of the liquid was higher than it subsequently comes to be, contraction of the fluid in the enclosed cavity takes place, and a bubble or vacuole is formed. The relative volume of the vacuole to the dimension of the cavity may be taken as a rough indication of the temperature of the solution at the time of crystallisation.

The minerals most commonly containing fluid cavities are quartz (rock crystal, chalcedony, &c.), topaz, emerald, &c. In some specimens of quartz, the milky appearance is entirely due to myriads of minute cavities.

The contained fluid usually consists of either water or an aqueous solution of salts—commonly chloride of sodium. In this latter case crystals of chloride of sodium may often be seen in the fluid. Besides the above, solution of carbonic acid is met with, and even pure liquid carbonic acid.

No. 1 is a specimen of chalcedony from Uruguay, and is chiefly remarkable for the quantity of fluid contained, it being about 60 grains. On shaking, the fluid may be heard to rattle, and the mineral being transparent the bubble

may easily be seen on holding the specimen to the light. Another peculiarity is the absence of any indications of attachment to any other body on the surface of this mineral, rendering its mode of formation a matter of doubt.

No. 2 is a crystal of quartz from Brazil. Three cavities may be seen; one about one-eighth of an inch in diameter contains a viscid fluid, together with a vacuole and an irregular black fragment of mineral matter. Both these are when the specimen is rotated. One of the other cavities contains fluid and a portion of rock magma. In neither of these specimens (1 and 2) can the vacuoles be made to disappear by heat.

No. 3. A piece of rock-crystal containing numerous flattened irregular cavities. Each is seen to contain a flattened vacuole, surrounded by fluid, which fluid is separated from the walls of the cavities by a space which, according to Brewster, contains a second fluid of different optical density. On heating, the vacuole is seen to decrease in size, and finally to disappear. The contour line of the second fluid remains unchanged. On cooling, the vacuole reappears.

No. 4. Section of quartz containing fluid cavities, each containing a crystal of common salt and a vacuole. The vacuoles are motionless and do not disappear on heating.

No. 5. Section of Granite. The fragments of quartz in this specimen abound with minute more or less spherical cavities. Each contains a vacuole which in the large and medium sized cavities may be seen when highly magnified (¼ in.) to rise to the upper part of the cavity when the specimen is rotated. Warming facilitates this, apparently rendering the fluid less viscid. The feature of interest in this specimen is the spontaneous movement of the vacuoles. At ordinary temperature the motion of the largest vacuoles consists in a faintly perceptible throbbing motion; in the medium sized this is increased, while in the smaller cavities the vacuole wanders about its cell with a rapid jerking motion; on applying heat the vacuoles gradually decrease in size, and become more active as they become smaller, until finally, before disappearing, their motion becomes too rapid to follow, but is chiefly confined to the upper part of the cavity. If allowed to cool, the vacuole suddenly reappears of its full volume at the lower part of the cavity, instantly rising to the top. The motion of the smaller vacuoles seems incessant, but I have never observed them at a freezing temperature. If the source of heat, whether a heated metal or glass rod, be applied either on one side or at the upper or lower part of the cavity, the vacuole at once passes to that side, and in this way may be made to pass to any part of its cell by moving the heat source in the desired direction. Whether such movement is an attraction of the vacuole, or a repulsion of its surrounding fluid, is not easy to decide. That it is not due to the nature of the heating body is shown by its occurrence from proximity of any heated substance, whether of glass or metal. The vacuoles in the smaller mineral cavities are interesting as being the smallest isolated portions of gaseous matter observable, and their extraordinarily active movements in a comparatively dense medium seems suggestive of the kinetic theory of matter.

NOTICES OF BOOKS.

A Text-Book of Inorganic Chemistry. By Prof. VICTOR VON RICHTER. Authorised Translation by EDGAR F. SMITH. Second American from Fourth German Edition. Philadelphia: Blakiston, Son, and Co. London: Trübner and Co.

WE learn from the preface to the first edition that the periodic system is "made the basis of the present volume." Such being the case it is the more to be regretted that whilst ample credit is given to Professors Mendeleeff and Meyer, Mr. J. A. R. Newlands is completely ignored. Yet this chemist's priority as regards the main features of the periodic system is established beyond the shadow of doubt. It is surprising that neither Prof. von Richter nor Prof. E. F. Smith has met with the original papers of Mr. Newlands in the CHEMICAL NEWS or in other journals in which they have been reproduced. A prominent feature of this work is the attention paid to thermochemistry—a branch of the science too generally overlooked in text-books, though it is acquiring increased importance.

We regret to notice the frequent use of the word "metalloids" for the non-metallic elements.

One very important passage calls for special and — in our opinion at least—most favourable notice. We read:— "The fundamental deduction necessarily resulting from the law of periodicity is, that the various elementary atoms must be aggregations or condensations of one and the same primordial substance, a necessary correlative postulate of the recognised unity of all forces. Then only can we comprehend that the properties of the elements are functions of the atomic weight."

Concerning Prout's hypothesis the author reserves judgment, pending the exact determination of the atomic weights of a majority of the elements. But he duly notes the fact that, of the simple bodies whose atomic weights have been already ascertained with precision, at least one-half closely approximate to the demands of the law.

Had the author of this work been willing to render honour where honour is due, it would merit our almost unqualified commendation. As it is, it will be of great value to the student from the author's successful endeavours to bring fact and theory into harmonious relation.

The index is not unimpeachable.

Chemistry of the Carbon Compounds; or Organic Chemistry. By Prof. VICTOR VON RICHTER. Authorised Translation by E. F. SMITH, Professor of Chemistry, Wittenburg College, Ohio. From the Fourth German Edition. Philadelphia: P. Blakiston, Son, and Co. London: Trübner and Co.

PROFESSOR VON RICHTER'S work has the merits of being singularly clear, well-arranged, and, for its bulk, comprehensive. Hence it will, as we find it intimated in the preface, prove useful not merely as a text-book, but as a manual of reference.

In the introduction the author lays due weight on the distinction between *organic* and *organised* bodies. Still, even with this reservation, it seems hazardous to state that "all substances belonging to plants and animals can be artificially prepared from the elements." Most of the artificial organic bodies now so commonly prepared have their starting-point, not in the elements, but in the residues of matter once organised.

As regards the translation the language employed is in some cases open to question. Thus we read (p. 38) "The unsaturated compounds boil some higher than those saturated," and on the next page we find mention of a drawn out tube "fused shut at one end." In speaking (p. 600) of dyeing with indigo, Prof. E. Smith writes:— "the indigo blue is changed by fermentation to indigo white, the weaving saturated from the latter and exposed to the air." Instead of "weaving," the tissue or the cloth would be the ordinary English rendering of the German "Gewebe."

Throughout the book there occur similar peculiarities of expression, which give a jar to the reader's mind, and may make him for a moment doubtful as to the meaning which the translator desires to convey. With a little care these flaws in an otherwise excellent work might have been kept out.

Illustrated Handbook of Victoria, Australia. 1886. Melbourne: John Ferres.

THIS most interesting work on the colony of Victoria was specially prepared for the Colonial and Indian Exhibition,

with a view to bringing the capabilities and resources of the country more prominently before the people of older England.

The first expedition to Australia of which any record is left was in the year 1616, and the first settlement was made in January, 1788.

The mineral wealth of Australia is enormous, and the discovery of gold in 1851 had more to do with the rapid rise into importance of the colony than years of "squatting" would have done. Gold is found in two principal formations, viz :—In quartz, and in alluvial beds; the first named is mined in a similar manner to other metalliferous lodes, and after crushing the quartz the gold is separated by means of mercury. Alluvial gold, on the other hand, is generally found with gravel or loose soil, and is separated by washing; full descriptions of both these methods are here given, with the weight and value of the gold produced.

Sheep farming and cattle raising being important branches of industry in Victoria, are also fully treated; wine growing also attracts considerable attention. But what is most striking on looking through this book, is the wonderful progress the colonists have made in beautifying their cities.

At the end of the volume are 74 full page engravings of the principal buildings, streets, public monuments, &c., in this colony, which testify to the energy and perseverance of those who are making a new England for future generations.

Report of the Port of London Sanitary Committee : with the Half-yearly Report of the Medical Officer of Health for the Port of London, to December 31, 1886.

In this last report of the sanitary condition of the Port of London, during the latter half of 1886, Dr. Collingridge is happy in not having to record much sickness of an infectious nature, the whole year having been unusually free from disease of this nature.

Appendix A shows that during the last six months of the year no less than 11,064 vessels of all classes were inspected by the officers of health, 84·44 per cent (that is 9343) being British; of these, 798, or 7·2 per cent, were found to require cleansing of some sort. It is encouraging to note that in such instances the verbal order of the inspector is almost always sufficient, the necessity of further proceedings being very rare, and then only when some special reason exists. Only six vessels have had to be fumigated on account of infectious diseases, a smaller number than in any half year since 1879.

This Committee has not only to deal with the sanitary condition of the vessels arriving in London, but also with the condition of the river on which this port is situated; the problem is a serious and most important one, and although it is some years since the first experiments in this direction were made, we are sorry to see that little or no progress has been made in keeping the river free from contamination with the large amount of sewage which has daily to be disposed of. The uncertainty of our climate, says Dr. Collingridge, always affords a hope that during the summer there will not be a sufficiently long period of hot weather to cause the terrible nuisance to reappear, and unfortunately this uncertainty has been made the most of. The large experiment that the Board of Works are about to spend half a million on is now tolerably well known, but it is hardly to be hoped that much, if any, benefit will result therefrom. During last summer 9 million gallons daily were treated with lime and sulphate of iron, and then, before discharging, with permanganate of soda as a deodoriser. The result was unsatisfactory, except in cool weather, but when in August the temperature rose the river water became foul and discoloured (the natural result of using iron salts) giving off the usual horrible stench. The presence of cholera on the Continent has again attracted the attention of this committee, who have been successful in keeping the Port of London free from that terrible scourge; in commenting on the passage of the "Euphrates" through the Suez Canal while infected with cholera, the writer of this report says, "such a procedure must, of necessity, be a great blow to the dangerous and barbarous system of quarantine," an opinion which we think will be pretty generally endorsed, at least in this country.

Bulletins Nos. 5, 6, and 7 of the Louisiana Sugar Experiment Station. By Wm. C. Stubbs, Ph.D. Baton Rouge, U.S.A., 1886.

These three bulletins deal respectively with the cultivation of sorghum, corn, and sugar-cane. The first and third have been carefully experimented with in order to find the best manure to give a large yield of sugar, while the yield of grain has been the object in the other case. Sorghum has been cultivated in the United States of America and elsewhere for a number of years, and has been used largely as forage for cattle. For nearly thirty years the Americans have been trying to make sugar from it, but in China, where we are told it has been cultivated for thousands of years, there is no evidence that it has ever been used with that view. The origin of sorghum is utterly unknown; its habits and characteristics have been so changed by long cultivation that it cannot be found to resemble any wild plant. These experiments are the first that have been made in a systematic manner, but as yet the success achieved has only been partial; there were three experiment stations, *a*, *b*, and *c*.; *a* was fertilised with ammoniated acid phosphate, *b* was unfertilised, and *c* with ammoniated acid phosphate and a little chloride of potassium.

The results of the analyses, which were made at short intervals, are given in a table. Of the different varieties used the Chinese was the first to ripen, and though rich in sugar it is too small a plant to be profitably worked; Indian sorghum is a fine variety and gave a very good yield; but the variety known as Sink's Hybrid is said to be the best adapted for the production of sugar. The highest individual yield of sucrose was 50 per cent, and was obtained from plot *c*, from the Honduras sorghum, though in most cases the fertiliser used has made little or no difference.

The sugar-cane has been known from time immemorial, but it is believed to have come originally from India; rich soils filled with vegetable matter are best suited to it. The field experiments at the station during the past year were of four kinds, viz. :—

1st. Germination questions.
2nd. Physiological questions.
3rd. Varieties best adapted to Louisiana.
4th. Manurial requirements.

The old question among planters as to which part of the cane should be planted, that is to say, the tops, the entire stalk, or only the matured parts, has been carefully tried; the experiments were, however, to a large extent vitiated by the bad weather, but the best results were obtained from the plot planted with the partially green third and fourth joints from the top of the cane. These experiments will be tried again.

Many persons have long been of the opinion that side shoots which spring up round the base of the original plant, known as "suckers," were very detrimental, on the grounds that they took their nourishment from the centre stalk. This has been found not to be the case, the "suckers" actually increasing the yield of sugar.

Passing over the experiments to decide what variety is the best suited to Louisiana, we come to those on manurial requirements. The first of these experiments made with various quantities of cotton seed, phosphate, kainite, gypsum, "floats" (bone dust and Charleston phosphate), stable manure, &c., shows that a mixture of cotton seed meal and an acid phosphate produces the highest results, that kainite adds nothing to the crop, and that the application of manure in the autumn is as bene-

ficial as when applied in the spring. Phosphoric acid gives an increase in the yield, but after a certain amount the increase is not in proportion to the quantity applied; from this it is very naturally concluded that large quantities are useless and expensive.

The results obtained from the trials with chloride, sulphate, nitrate, and carbonate of potassium, and kainite (sulphate of potash and magnesia) were discordant and very unsatisfactory; for the largest yields came from the unfertilised plots.

The cultivation of corn depends to a very great extent on the locality, corn being essentially a child of the sun, and no fixed rules applicable to all countries can possibly be given. Corn should never be planted until the temperature of the soil one inch below the surface is above 50° F. The rule here given as to the time of planting is a quaint one, viz., "When the leaves of the white oak get as big as a squirrel's ear": this sounds rather vague, the size of a "squirrel's ear" being a variable quantity, but it is said to be correct.

A large number of experiments were tried with different manures, as in the other cases, but the results do not appear to be of much value, owing to depredations made by birds on the one hand and worms on the other.

The director of this station is carrying out a very useful work, but the reports are marred by innumerable printer's errors and mistakes.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 7, February 14, 1887.

Physical Researches on the Isomerism of Position—Alb. Colson.—The author finds that the three isomeric carbides, paraxylene, orthoxylene, and metaxylene, which present a remarkable parallelism in their chemical reactions are also connected by physical relations, especially if studied calorimetrically.

Action of Mercury upon Some Chlorides in Solution.—G. André.—The author examines the behaviour of mercury oxide with calcium, barium, strontium, and magnesium chlorides.

Action of Hydrochloric Acid upon the Solubility of the Chlorides.—R. Engel.—The author has shown in a former memoir that the solubility of the chlorides which hydrochloric acid precipitates from their aqueous solutions decreases, in presence of this acid, by a quantity corresponding approximately to an equivalent of chloride for each equivalent of hydrochloric acid added. This law, which is only an approximation, holds good, especially at the outset of precipitation, and in many chlorides three-fourths of the salt in solution are precipitated according to this law. On further examination this fact has been found very general. Metallic chlorides of the most different groups, those whose crystals are anhydrous and those which have water of crystallisation, the very soluble, and the sparingly soluble, follow this law at the outset of their precipitation with hydrochloric acid. No relation appears between the point after which the precipitation of a salt begins to deviate from it, and the other physical and chemical properties of the salt. Similar phenomena are observed in the action of nitric acid upon the solutions of the nitrates. Sulphuric acid behaves quite differently when acting upon the solutions of sulphates with which it does not form acid sulphates.

Poisonous Character of Colchicine.—A. Mairet and Combermale.—Colchicine acts as an irritant poison, affecting all the organs, but especially the digestive canal and the kidneys. The minimum fatal dose of colchicine for dogs and cats is 0·000571 grm. per kilo. of the weight of the animal, if introduced hypodermically, but 0·00125 grm. per kilo. if introduced into the stomach. Colchicine is eliminated by different channels, but this process is slow, whence slight but repeated doses, 0·00016 grm. per kilo., may prove fatal in five days.

New Process for determining the Carbonic Acid given off and the Oxygen Absorbed in Respiration.—M. Hanriot and Ch. Richet.—The air inspired traverses a gas-meter (I.) which measures its volume. The air expired traverses in succession two meters (I. and II.) between which is placed an apparatus for absorbing carbonic acid. The difference of volume registered between I. and III. gives the volume of oxygen absorbed, and the difference between II. and III. shows the volume of carbon dioxide produced.

No. 8, February 21, 1887.

Calcium Orthobutyrate and Isobutyrate.—G. Chancel and F. Parmentier.—The authors show that the generalisation of M. Le Chatelier (*Comptes Rendus*, c., 50 and 441) cannot be considered as the expression of a law from which new and certain deductions may be drawn.

Red Fluorescence of Aluminium.—Lecoq de Boisbaudran.—The author has continued his experiments on alumina, which has been ignited at different temperatures with the additions respectively of chromium and bismuth oxides.

The Determining Causes of the Phosphorescence of Calcium Sulphide.—A. Verneuil.—The author refers to a former paper (*Comptes Rendus*, ciii., 600) showing that to obtain a calcium sulphide giving a violet phosphorescence it is necessary to calcine a mixture of 100 parts of lime from the shell of *Hypopus vulgaris*, 30 sulphur, and 0·02 bismuth subnitrate. He finds now that the sulphide thus prepared owes its peculiar phosphorescence at once to the salt of bismuth, to sodium carbonate and chloride, and to the calcium sulphate formed during the reaction, and as an increase of the quantities of carbonate of soda and common salt does not notably increase the luminosity of the product, the shell must contain these fluxes in the best proportions for the effect required.

Action of Certain Metals upon Silver Nitrate in Dilute Solutions.—J. B. Senderens.—Lead, zinc, iron, cadmium, tin, antimony, aluminium, acting on dilute solutions of silver nitrate, reduce the nitric acid simultaneously with the precipitation of the silver. Corresponding phenomena are observed with other nitrates.

Action of Sulphuric Acid upon the Solubility of the Sulphates.—R. Engel.—Certain sulphates do not appear capable of combining with sulphuric acid to form double sulphates. If sulphuric acid is caused to act upon such sulphates, the solubility of the salt diminishes according to a different law from that which holds good for chlorides in contact with hydrochloric acid.

Reply to a Memoir by M. Boutroux concerning the Action of Nitric Acid upon Sugar.—E. Maumené.—The author maintains that his hexepic acid is absolutely identical with the oxygluconic acid of M. Boutroux.

On Sugaring Musts and on the Manufacture of Sugar Wines.—D. Klein and E. Frechou.—A sealed paper deposited by the authors in October, 1885, and now opened at their request. It treats of the addition of sugar to the juice of imperfectly ripened grapes.

A Contribution to the Study of the Alkaloids.—Oechsner de Coninck.—The author has previously shown that if the compounds of the pyridic and quinoleic acids with methyl and ethyl iodides are treated with potassa, very sensitive coloured reactions are produced. He finds that this is not the case with sparteine, which gives merely a rose colour. Nicotin gives a garnet-red colouration, which passes into a carmine and lastly into an orange-yellow. This reaction approximates nicotin to the pyridic and dipyridic alkaloids.

Justus Liebig's Annalen der Chemie, Vol. ccxxxvii., Part 2.

The Chloration of Toluol.—E. Seelig.—If dry chlorine is passed, in the dark, into toluol refrigerated with ice, no transferrer of chlorine being present, absorption first takes place, and nothing escapes save unabsorbed chlorine. After some time an escape of hydrochloric acid begins. The green colour of the toluol shows that it always contains notable quantities of chlorine in an unconverted state. Slight elevations of temperature occasion partial transformation and abundant escape of hydrochloric acid. Still more intense is the action of transferrers of chlorine, such as ferric chloride, which cause a brisk effervescence on their introduction. At first, therefore, there ensues merely an addition of chlorine, whilst substitution takes place afterwards.

Oxidation of Symmetrical Trialkyl-pyridin.—Sigm. Altar.—In this memoir the author studies the mono-carbon acids from symmetrical trialkyl-pyridins and their constitution, and the corresponding dicarbon acids.

Researches on Titanium (Second Memoir).—Baron Otto von der Pfordten.—The author's principal results are:—Rutile from St. Yrieux and from Norway always contains vanadium, which will probably be found also in rutile from other sources. This vanadium passes into the purified titanic acid, to which special attention must be given. The yellow compound which persistently clings to titanium chloride is not ferric chloride, but vanadium oxychloride. Hydrated titanic acid may appear in a gelatinous state. Titanium tetrachloride is reduced to dichloride at ordinary temperatures, both by sodium amalgam and by hydrogen sulphide. Titanium dichloride dissolves in alcohol and in water with a deep brown colour, and this relatively permanent solution is precipitated by reagents with formation of titanium monoxide compounds. For this stage of combination potassium sulphocyanide with ether gives a very characteristic and sensitive reaction, *i.e.*, the subnatant stratum becomes colourless, whilst the ether takes a deep brown colour. The solutions of the sesqui-compounds are, according to circumstances, either violet or green. The action of hydrogen upon titanic acid is not a method for preparing titanium sesquioxide, but yields a deep blue compound, Ti_7O_{12}. The author considers the preparation of the greatest possible number of compounds and the determination of their permanence essential to an understanding of the elements not yet thoroughly known. In the silicon group a comparison such as he has formerly carried out (*Annalen*, ccxxii., p. 142), is as yet impracticable, since in silicon, zircon, and thorium the lower stages have not been sufficiently studied, the intercalation of cerium is still doubtful, and the character of tin and lead is too different to allow of a useful comparison.

Behaviour of Phosphorus Pentachloride with Substituted Formamides, and on Certain Piperidine Derivatives.—O. Wallach and F. Lehmann.—This memoir does not admit of useful abstraction.

MISCELLANEOUS.

Phenol-phthaleine Test-Papers.—We have received from Messrs. James Woolley, Sons, and Co. a sample of their new phenol-phthaleine test-papers for detecting an excess of alkali in a solution. One of these papers when placed in a beaker of fluid assumes a bright magenta colour if alkali is present in excess, and on neutralising carefully with acid the colour disappears. These papers will no doubt prove very useful in the laboratory, the reaction being more distinct than that of litmus.

Bronzing of Metals.—Very handsome colours may be imparted to metals, according to *Metallarbeiter*, by the use of cold solutions of the sulphides of arsenic or antimony. The articles are thoroughly cleaned and dried; a thin layer of a dilute solution of polysulphide of ammonium is applied with a soft brush, allowed to dry, and after brushing off the separated sulphur, a dilute ammoniacal solution of sulphide of arsenic is applied. The colour thus produced resembles that of mosaic gold, and becomes deeper and ultimately dark brown by repeating the application of the arsenic solution. A solution of sulphide of antimony produces a rose-coloured tint, which may be deepened to dark red. By polishing, the coating acquires a bright metallic lustre, and by the use of mordants the colour is altered. Brass or bronze left for a long time in contact with the mordant becomes superficially greenish grey, and quite glassy on being polished with cloth; if now treated with the above solutions a dull yellow colour is produced. The bronzing layer may be re-dissolved by ammonia or sulphide of ammonium, and the sulphides of antimony and arsenic may be dissolved in hydrate or sulphide of potassium or sodium.—*American Journal of Pharmacy*.

The Chemical Laboratory of Wiesbaden.—The Chemical Laboratory of Geh. Hofrath Prof. Dr. Fresenius at Wiesbaden enjoys a very large attendence. In the winter term, 1886-87, there were 77 students on the books. Of these, 53 were from Germany, 5 from England, 5 from North America, 4 from Austria, 3 from Russia, 2 from Belgium, 2 from Italy, 1 from France, 1 from Spain, and 1 from Sumatra. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment Prof. Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. med. F. Hueppe, and Architect Brahm. The assistants in the instruction laboratory were two in number, in the Versuchsstation three. During the last term, besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory and the Versuchsstation on behalf of manufacture, trade, mining, agriculture, and hygiene.

Jubilee Exhibition at the School of Science of the City and County of Lincoln.—The friends of science are requested to favour this new, handsome, and important scientific college with the loan of anything of interest in the physical and natural sciences, such as rare scientific works, specimens of minerals, crystals, rare metals, models of chemical plant and machinery, inventors' apparatus, or original specimens of chemicals, &c. The President of the Exhibition is the Right Hon. Earl Brownlow, and the Committee include, amongst numerous others, the Most Hon. Marquis of Ripon, Earl Yarborough, Viscount Oxenbridge, Lord Bishop of Lincoln, His Honour Judge Stephen, LL.D., Dean of Lincoln, Mr. Chaplin, M.P., Mr. Kerans, M.P., Mr. Waddy, Q.C., M.P., Right Hon. E. Stanhope, M.P., Right Hon. E. Heneage, M.P., the Mayors of Lincoln, Grantham, Boston, Grimsby, Louth, and Stamford, Dr. A. B. Griffiths, F.R.S. (Ed.). A guarantee fund to indemnify the General Committee amounts to far over £1000, and will be doubled if necessary. Intending exhibitors can obtain forms and full information from Dr. Griffiths, School of Science, Lincoln. The Exhibition opens on June 22nd, but all intending exhibitors are requested to make application before April 31st next. This Exhibition is intended to be the "ornamental opening" of the new buildings of the Science School of Lincoln. After June 22nd, they will be known as the "Victoria School of Science of the City and County of Lincoln."

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Hard Water and Stone.—I shall be obliged if any one can inform me if there are any statistics published showing any connection between the prevalence of stone and the hardness of the water supply

I have heard it stated that stone is most frequent in hard water districts. Is there any truth in this statement, or does the accretion depend upon personal idiosyncracy? I once knew a man at Market Harbro' who passed a stone from the kidneys, and he declared it was entirely due to the hard water. In my own district lives a man who is in the habit of indulging in this habit, and yet the water is not very hard—about 12°. I have lately analysed a water (from Worcestershire) which has a total hardness of 42°, permanent hardness 30°. I felt bound, in my report, to mention that hard water has been *accredited* with the power of forming deposits in the system, but that this is a medical rather than a chemical question, concerning which, I believe, doctors differ.—Sm.

MEETINGS FOR THE WEEK.

Monday, 21st.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Machines for Testing Materials, especially Iron and Steel," Prof. W. C. Unwin, F.R.S.
Tuesday, 22nd.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Royal Institution, 3. "Function of Respiration," by Prof. Arthur Gamgee, F.R.S.
Wednesday, 23rd.—Society of Arts, 8. "Some of the Conditions affecting the Distribution of Micro-Organisms in the Atmosphere," by Dr. Percy Frankland.
—— Geological, 8.
Thursday, 24th.—Royal, 4 30.
—— Royal Institution, 3. "The Science of Thought," by Prof. F. Max Müller, M.A., LL.D.
—— Royal Society Club, 6.30.
—— Telegraph Engineers, 8.
Friday, 25th.—Royal Institution, 9. "Colours of Thin Plates," by the Right Hon. Lord Rayleigh, M.A., F.R.S.
—— Society of Arts, 8. "Indian Coffee," by Frederick Clifford.
—— Quekett Club, 8.
Saturday, 26th.—Royal Institution, 3. "Sound," by the Right Hon. Lord Rayleigh.
—— Physical, 3. "On the Production of the Finest Fibres," by Mr. C. V. Boys. "On Delicate Calorimetrical Thermometers," and "On the Expansion of Thermometer Bulbs under Pressure," by Prof. Pickering.

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THE CHEMICAL NEWS.

Vol. LV. No. 1426.

ON RADIANT MATTER SPECTROSCOPY:—EXAMINATION OF THE RESIDUAL GLOW.*

By WILLIAM CROOKES, F.R.S. V.P.C.S.

(Concluded from p. 121).

The different action of calcium, barium, and strontium on the constituents of yttrium is an additional proof, if confirmation be needed, that the bodies I have provisionally called Gα, Gβ, Gδ, &c.,† are separate entities. It may be as well here to collect together the evidence on which I rely to support this view. I will take the bodies *seriatim*:—

Gα.—An earth phosphorescing with a blue light, and showing in the spectroscope a deep blue line, of a mean wave length 482. This earth occurs in different proportions in purified yttria from different minerals. Samarskite, gadolinite, hielmite. monazite, xenotime, euxenite, and arrhenite contain most Gα, whilst fluocerite and cerite contained notably less of this constituent. The addition of lime brings out the phosphorescence in Gα in advance of that of the other constituents. The behaviour in the phosphoroscope of Gα when mixed with the alkaline earths also points to a difference between it and its associates. With lime the blue phosphorescent band of Gα comes into view at a very low speed, the order of appearance with a small quantity of lime being Gβ Gα, Gδ, and with a large quantity of lime, Gδ, Gα, Gβ. Employing strontia instead of lime the order of appearance in the phosphoroscope when the quantity of strontia is small is Gβ, Gα, Gη, and when the quant ty of strontia is in excess, Gα, Gη, Gβ. Baryta in small quantity brings out the lines in the phosphoroscope in the following order, Gβ, Gα, Gη, but when the baryta is in excess the order is Gβ, Gη, Gα. The chemical position taken up by Gα in the fractionation ccheme precludes it from being due to the bodies I have salled Gβ, Gγ, Gε, Gζ, Sγ, or Sδ. It closely accompanies Gδ (the earth giving the citron line), concentrating at the least basic end, and I have not yet succeeded in effecting a separation of the two. If, therefore, Gα is not a separate entity, its blue line must be due to the citron-band-forming body called Gδ. The difference between Gα and Gδ is brought out in a marked manner by the phosphoroscope when baryta or strontia is present; the citron line of Gδ being entirely suppressed, while the blue line of Gα is brought out with enhanced brilliancy. For these reasons I am inclined to regard Gα as a separate body, although the evidence in favour of this view is not so strong as in the case of some of its other associates.

Gβ.—An earth phosphorescing with green light and showing in the spectroscope a close pair of greenish-blue lines of a mean wave length of 545. This earth can be separated by chemical fractionation from the other constituents of yttrium. It concentrates at the most basic end, and is present in the samarium which invariably makes its appearance at this end of the fractionation of yttrium. It is one of the prominent lines in Yα, where also it accompanies some of the samarium lines. Gβ, however, is not a constituent of samarium, for it is easy to purify samarium by chemical means so that it does not show a trace of the Gβ green lines, although it is very difficult to get Gβ free from some of the samarium lines. The residual phosphorescence of Gβ is very considerable, and its green lines show first in the phosphoroscope when only yttrium is present. The addition of lime keeps back the glow of Gβ and brings forward that of Gδ. Strontium and barium act on Gβ very differently to lime. A small quantity of strontium brings forward the residual glow of Gβ, whilst in large quantities strontium keeps the phosphorescence of Gβ back to the last.

Gγ.—An earth phosphorescing with a green colour and showing in the spectroscope a green line having a wave length of 564. This is one of the least definite of all the supposed new bodies. It appears to be a constituent of samarium, occurring in the fractionation of yttrium among the most basic constituents connecting yttrium and samarium. Its point of maximum intensity is, chemically, very well marked, and is at a different part of the fractionation scheme to those of the other lines of samarium, especially Gε. On dilution with lime the phosphorescent line of Gγ vanishes before that of Gε.

Gδ.—An earth phosphorescing with a citron coloured light and showing in the spectroscope a citron line having a wave length of 574. Gδ is one of the least basic of all the bodies associated in yttrium, occurring almost at one extremity of the fractionation. It is not very difficult to separate chemically Gδ from all the other accompanying bodies except the one which I have called Gα (giving the deep blue line). Not only can Gδ be obtained free from the other four constituents of yttrium, but the body called by M. de Marignac Yα is a proof that the other four components of yttrium can be obtained quite free from Gδ. Lime intensifies the phosphorescence of Gδ, and deadens that of Gβ, while strontium has the opposite action The behaviour of Gδ in the phosphoroscope, when mixed with lime, strontia, or baryta, also affords a striking evidence of individuality; lime enhancing the residual glow, while strontia and baryta altogether suppress it.

Gε.—An earth phosphorescing with a yellow colour, and, in the spectroscope, showing a sharp yellow line having a wave length of 597. It is seen in the samarium spectrum as a sharp yellow line superposed on a hazy double band. As I have already pointed out, Gε fractionates out high up among the most basic earths and generally accompanies lanthanum. In the phosphorescent spectrum of lanthanum the line of Gε is seen quite free from the lines of other bodies.

Gζ.—An earth phosphorescing with a red light, showing in the spectroscope a red line of wave length 619. This body is always more plentiful in yttrium obtained from samarskite and cerite than from gadolinite, hielmite, and euxenite, and is almost absent in yttrium from xenotime. Gζ is of about intermediate basicity. Working with samarskite yttria, Gζ becomes most brilliant after the line of Gη has completely disappeared. Further fractionation causes the line of Gζ to fade out, and the citron and blue lines are then left.

The phosphorescence of Gζ is developed to a different extent according to the metal with which the yttria is mixed. The order (beginning with the substance having the greatest action) is zirconium, tin, aluminium, bismuth, glucinum.

Gη.—An earth phosphorescing with a deep red light, and showing in the spectroscope a red line having a wave length of 647. Like its fellow red constituent, Gη occurs most plentifully in samarskite yttrium, and scarcely at all in yttrium from hielmite, euxenite, and cerite. It is the first of the strictly yttrium constituents to separate out, on fractionation, at the most basic extremity, leaving Gα, Gβ, Gδ, and Gζ. In almost all samples of yttria, except when very highly purified, Gη is seen very brilliantly, and by its side can be detected the faint red band of samarium. In the phosphoroscope the line of Gη is the last to appear when yttria alone is being observed; strontia and baryta enhance the residual glow of Gη, strontia in moderate quantities bringing it out before that of Gβ, while baryta brings it out after Gβ.

Sδ.—An earth giving in the spectroscope when phosphorescing a very sharp orange line of wave length 609. I have already* discussed [the claims of this earth to be

* A Paper read before the Royal Society, Feb. 17, 1887.

† *Roy. Soc. Proc.*, vol. xl. (1886), p. 502.

* *Roy. Soc. Proc.*, vol. xl. (1886), p. 504.

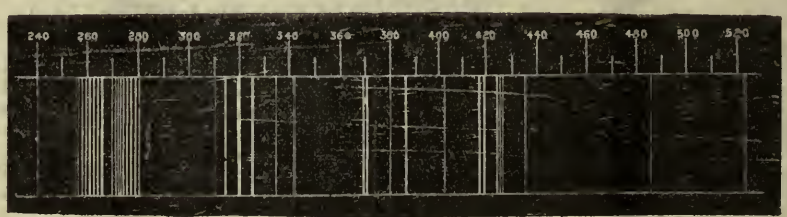
considered a separate entity. It is not present in the rare earths from gadolinite, xenotime, monazite, hielmite, euxenite, and arrhenite; it is present in small quantity in cerite, and somewhat more plentiful in samarskite. In samarskite yttrium it concentrates at a definite part of the fractionation. Its sharp orange line is not strong enough to be seen in the phosphoroscope. A little calcium entirely suppresses the orange line, while samarium or yttrium seems to intensify it.

In addition to the above earths, it is not improbable that the sharp green line $\left(\frac{1}{\lambda^2}\ 325\right)$ mentioned under the heading "Yttrium" may be caused by still another earth.

The brilliant and characteristic spark spectra yielded when certain elements are volatilised and rendered incandescent by the spark from a powerful induction coil are relied on by chemists as an indisputable proof of the identity of such elements. Bearing this in mind I have endeavoured to ascertain how these yttrium constituents would behave in respect to the spark spectrum. Do the definite system of lines in the old yttrium spark spectrum belong to one constituent only, or are the yttrium lines broken up and distributed among the different bodies I have designated as Gα, Gβ, &c.? Also do the other constituents possess special spark spectra of their own? Very careful and long continued experiments have shown me that neither of these hypothetical cases occur.

The spark spectrum given by old yttrium is shown in the drawing (Fig. 5). It is chiefly characterised by two

Fig. 5.



very strong groups of lines in the red and orange. I now take the earth Gδ. This occurs near one end of the fractioning, and not only differs from the parent yttrium in its phosphorescent spectrum, but by virtue of the process adopted for its isolation it must likewise differ in its chemical properties. On examining its spark spectrum I see absolutely no difference between this spectrum and the one given by old yttrium.

I now pass to the other end of the fractionation of yttrium, where occurs a concentration of a body giving a totally different phosphorescent spectrum to the one at the first end. And it also differs chemically from old yttrium, and in a more marked manner from its brother, Gδ, at the other extremity of the fractionation. Here again its spark spectrum is perfectly identical both with old yttrium and with Gδ, and however closely I examine these three spectra in my laboratory, the whole system of lines is still identical.

Respecting the theoretical considerations involved in these results, I see two possible explanations of the facts brought forward. According to one hypothesis research has somewhat enlarged the field lying between the indications giving by ordinary coarse chemistry and the searching scrutiny of the prism. Our notions of a chemical element have expanded. Hitherto the molecule has been regarded as an aggregate of two or more atoms, and no account has been taken of the architectural design on which these atoms have been joined. We may consider that the structure of a chemical element is more complicated than has hitherto been supposed. Between the molecules we are accustomed to deal with in chemical reactions and the ultimate atoms, come smaller molecules or aggregates of physical atoms; these sub-molecules differ one from the other, according to the position they occupied in the yttrium edifice.

An alternative theory commends itself to chemists, to the effect that the various bodies discussed above are new chemical elements differing from yttrium and samarium in basic powers and several other chemical and physical properties, but not sufficiently to enable us to effect any but a slight separation. One of these bodies, Gδ, gives the phosphorescent citron line, and also the brilliant electric spectrum. The other seven do not give electric spectra which can be recognised in the presence of a small quantity of Gδ, whilst the electric spectrum of Gδ is so sensitive that it shines out in undiminished brilliancy even when the quantity present is extremely minute. In the process of fractionation, Gα, Gβ, Gδ, &c., are spread out and more or less separated from one another, yet the separation is imperfect at the best, and at any part there is enough Gδ to reveal its presence by the sensitive electric spark test. The arguments in favour of each theory are strong and pretty evenly balanced. The compound molecule explanation is a good working hypothesis, which I think may account for the facts, while it does not postulate the rather heroic alternative of calling into existence eight or nine new elements to explain the phenomena. However, I submit it only as an hypothesis. If further research shows the new element theory is more reasonable, I shall be the first person to accept it.

Neither of these theories agrees with that of M. Lecoq de Boisbaudran, who also has worked on these earths for some time. He considers that what I have called old yttrium is a true element, giving a characteristic spark spectrum, but not giving a phosphorescent spectrum *in vacuo*. The bodies giving the phosphorescent spectra he considers to be impurities in yttrium. These he says are two in number, and he has provisionally named them Zα and Zβ. By a method of his own, differing from mine, M. de Boisbaudran obtains fluorescent spectra of these bodies; but their fluorescent bands are extremely hazy and faint, rendering identification difficult. Some of them fall near lines in the spectra of my Gβ and Gδ. At first sight it might appear that his and my spectra were due to the same bodies, but, according to M. de Boisbaudran, the chemical properties of the earths producing them are widely distinct. Those giving phosphorescent lines by my method occur at the yttrium extremity of the fractionation, where his fluorescent bands are scarcely shown at all; whilst his fluorescent phenomena are at their maximum quite at the terbium end of the fractionation, where no yttrium can be detected even by the direct spark, and where my phosphorescent lines are almost absent.

Action of Heat upon Heptene.—Adolphe Renard.—Heptene, under the influence of heat, is decomposed principally into toluene and hydrogen, whilst a certain quantity of its lower homologues, hexene and pentene, are simultaneously formed. The benzine is doubtless derived from a partial destruction of the hexene.—*Comptes Rendus* civ., No. 9.

ON THE

BEHAVIOUR OF ALKALINE SOLUTIONS OF PHENOL-PHTHALEIN IN THE PRESENCE OF ALCOHOL.

By HARRY NAPIER DRAPER, F.C.S., and CARTER DRAPER

Part I.—Ammonia and Phenol-Phthalein.

The observation which led to the following enquiry was made by one of us about two years ago. Some methylated spirit, supposed to contain ammonia, having been tested with phenol-phthalein with negative result, the experiment was repeated with alcohol to which aqueous ammonia had been added. *The liquid remained colourless.* This phenomenon was so unexpected and remarkable, and so obviously demanded explanation, that a series of experiments was begun, the deductions from which, simple as they now appear, have often been so baffling and enigmatical as to necessitate digressions from the experimental method at first laid down. As, however, these digressions have led to an extension of the field of enquiry, and the inclusion in it of the deportment of phenol-phthalein with the hydrates of potassium and sodium when alcohol is present, we cannot feel that they are to be regretted.

Phenol-phthalein ($C_{20}H_{14}O_4$) is, as might be inferred from the analogy of its constitution to that of fluorescin ($C_{20}H_{14}O_5$), a weak acid. Baeyer indeed points out that it forms unstable salts.

The same chemist notes that the colour of solutions of these salts is destroyed by excess of caustic alkali and is restored by addition of acid (to partial neutralisation). Also that when a solution of phenol-phthalein in ammonia is boiled, the ammonia is expelled and the phenol-phthalein separates.*

But why should the addition of alcohol to an ammonia solution of phenol-phthalein destroy its colour? Baeyer and Burkhardt† have pointed out that aqueous ammonia at high temperatures acts readily upon phenol-phthalein, forming a compound, di-amidophthalein, which crystallises in colourless needles, and to which they assign the constitution—

$$C_6H_4\begin{cases}C.NH.C_6H_4.OH\\C.NH.C_6H_4.OH.\end{cases}$$

Long, in an excellent paper‡ on the interference of salts of ammonia with the phenol-phthalein colour reaction in volumetric analysis, explains it on the hypothesis that with nascent ammonia the imido compound would probably be formed at ordinary temperatures, and his observation, that the decolouration is more rapid as the temperature of the liquid is higher, supports this theory; indeed phenol-phthalein in presence of concentrated aqueous ammonia is quite readily converted in a few days, at 40° C., into the imido compound.§

At first sight, therefore, it did not appear unreasonable to suppose that alcohol, by its affinity for water, played the part of time or heat, and caused a weak ammonia solution to behave like a stronger and non-alcoholic one. But an objection fatal to this theory soon presented itself. A solution of di-imidophthalein remains colourless when diluted with water to any extent, while the colourless compound formed in alcohol has its colour at once restored on addition of water. It was obvious, then, that some other cause for the phenomenon must be sought out.

In order that experiments made with this object might be comparable among themselves, two standard solutions were prepared as follows:—

Phenol-phthalein	1 grm.
Absolute alcohol	100 c.c.
NH_4OH	1 grm.
Water	100 c.c.

If equal volumes of these solutions be mixed, the coloured mixture is rendered colourless by addition of alcohol. The mean result of several experiments gave the quantity of alcohol required for 1 c.c. of each solution, at a temperature of 10°, as 3·1 c.c. If to the decolourised liquid water be added, the colour is again restored, to be again destroyed by addition of alcohol and restored once more by further addition of water. If the alcohol used be *boiled* before its addition to the coloured liquid, a considerably greater quantity is required—the temperature being the same—than in the case of unboiled alcohol. For example, in one experiment at 12° C., where 10 c.c. of each of the standard solutions were employed, the quantity of previously boiled alcohol required to effect decolouration was 40 c.c., while of unboiled alcohol 31 c.c. were sufficient to destroy the colour.* When to the solution decolourised by alcohol just sufficient water is added to restore the colour, it is at once rendered colourless by a very gentle heat. The colour returns on cooling, and the result is the same whether the experiment be made in a closed or in an open tube. The temperature required to effect decolouration varies so strikingly for each proportion of alcohol and water as to suggest the possibility of founding an approximate alcoholometric method upon the reaction. This itself is most easily demonstrated when, to equal volumes of phenol-phthalein and ammonium solutions of the above indicated strength, enough alcohol or ordinary rectified spirit is added to cause decolouration, and then just as much distilled water as is sufficient to produce a distinctly red tint.

The facts so far ascertained so clearly pointed to a dissociating action exerted by the alcohol, that the inference that the anhydrous compound of phenol-phthalein formed at ordinary temperatures is colourless, seemed unavoidable. That this inference is correct is, we think, demonstrated by the two following experiments:—

(*a.*) Bibulous paper (which had been previously prepared by treatment with dilute hydrochloric acid and repeated washing with distilled water) was dried at 100°, moistened with a solution of phenol-phthalein in alcohol, and again dried. This paper, when exposed to the action of ammonia vapour, remained uncoloured.

(*b.*) Paper prepared as above, and enclosed in an atmosphere of dry ammonia in a sealed tube for ten weeks, remained colourless; but at the end of this time, on being moistened with distilled water, became intensely red.

The phenomenon of decolouration by heat and restoration of the colour by cooling, of a weak ammonia phenol-phthalein solution to which not quite enough alcohol has been added to destroy the colour, may, if a sealed tube be employed, be repeated almost indefinitely. A mixture of—

Standard phenol-phthalein ..	10 c.c.
Standard ammonia	10 ,,
Alcohol	5 ,,

fulfils exactly the necessary conditions. A sealed tube containing this solution may be heated to 100° for half an hour, but that in this time and under these circumstances the colourless di-imido compound is not formed is shown by the complete return of the colour when the tube is cooled. But how far the heating of a liquid in which phenol-phthalein, ammonia, and alcohol bear these proportions, can be continued without permanent loss of colour we are unable to say, for after a more lengthened heating the liquid in the tube becomes permanently coloured. This at first puzzling reaction was, however,

* *Deut. Chem. Ges. Ber.*, xi., 1297, and *Journ. Chem. Soc.*, xxxiv., p. 866.

† *Journal of the Chemical Society*, vol. xxxviii., p. 653; and *Annalen*, ccii., pp. 36—140.

‡ Chemical News, li., p. 160.

§ Long's note, that partial neutralisation by an acid restores the colour, does not, however, point to the presence of the imido compound, which is not affected by acids.

* This fact—simply noted here, and not affecting the phenomena immediately under consideration—will later on be seen to acquire important significance.

finally found to be due to the solvent action of the liquid on the tube itself and the formation of a coloured sodium salt of phenol-phthalein. This was demonstrated by a number of experiments in which the ammonia was omitted from the solution, which, when heated in a sealed tube for an hour at 100°, became temporarily and slightly, but in from three to four hours strongly and permanently, coloured. Perhaps no experiment could be devised which would exhibit more strikingly than this, and at one and the same time, the solubility of ordinary glass at comparatively low temperatures, and the sensitiveness of phenol phthalein as a reagent.

We conclude, then, that the action of alcohol upon a dilute ammonia solution of phenol-phthalein is one of dissociation; that the loosely combined ammonia salt is, when anhydrous, colourless; and that alcohol, in decolourising it in its hydrated form, plays precisely the same part as when, in proportions alike dependent upon the amount of water present and the temperature employed, it converts into the blue anhydrous salt the cobalt chloride of a red aqueous solution.

(To be continued.)

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING FEBRUARY 28TH, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, March 7th, 1887.

SIR,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from February 1st to February 28th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The condition of the supply of water to the Metropolis during the past month, in respect more particularly to its degree of freedom from turbidity, has been far more satisfactory than it was during the month of January; when, owing to the occurrence of a sharp frost, supervening on floods brought about by the thawing of a heavy snowfall, the action of the filter-beds in general was much impaired just when most called upon, with the result of more or less turbidity being met with in some portion of the first fortnight's supply of water. During the past month no sample of Thames-derived water has been found otherwise than clear and efficiently filtered; while only one sample of Lea-derived water, out of the total 168 samples of water examined, has had to be recorded as "very slightly turbid," In respect also to its smaller proportion of organic matter, and more complete freedom from brown tint of colour, the supply of last month has shown a decided improvement; although indeed the proportion of organic matter present even in the January supply was not excessive for the time of year.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

THE ADULTERATION OF OILS.

By THOMAS T. P. BRUCE WARREN.

ANYONE who has paid much attention to the matter of oils must feel that we can hardly congratulate ourselves when we consider how little has been done, during the last twenty years, to render our knowledge of this very important subject more complete and trustworthy.

With a few trifling exceptions, indeed, all that appears from time to time in our chemical journals may be found in Chateau's "Corps Gras Industriels" (1864) and Fontenelle's "Manuel d'Huiles" (1866).

The following is taken from the *Standard* of the 7th inst., on the authority of their New York correspondent:—"The American Cotton-seed Oil Trust Corporation, whose capital is not publicly known, but is supposed to be about thirty or forty millions of dollars, monopolises the business after the methods of the Standard Oil Company; so that when, within four days, the stock fell from sixty-three to forty-two, the matter became one of world-wide importance. It appears that American lard, which is exported everywhere, is largely adulterated with cotton-seed oil. Messrs. Armour and Co., of Chicago, say they use one-fifth of the entire product in packing their lard. As the Trust held its oil too high, and even projected packing lard itself, the Armour Company is starting its own cotton-seed mills. A repetition of the oleo-margarine frauds appears not unlikely."

This announcement is such a glaring insult to the forensic talent of our analysts that I cannot longer refrain from publishing the value of a new reagent which is likely to be largely adopted.

In the manufacture of oleo-margarine in this country cotton-seed oil is more largely used than many would believe; hence English lard oil may not unreasonably be suspected of coming under the same category as the American.

A few months ago I had occasion to examine some samples of lard oil, both English and American. I had reason for pronouncing the American as adulterated with over 50 per cent of cotton-seed oil, and the English with about 25 per cent. More recently I have examined an American oil, and am able to speak a great deal more favourably on it. If adulterated at all, it is certainly not mixed with cotton-seed oil; so far I accept this as genuine lard oil.

Since lard oil is largely used as a lubricator, and is nearly double the price of cotton-seed oil, it is a matter of great importance to be able to detect its adulteration with cotton-seed oil.

Lard oil itself does not turn green so easily when placed in metal cups, as brass, bronze, &c., but if mixed with cotton-seed oil its action is very soon perceptible. The temperature at which a mixture of these two oils becomes pasty, as compared with lard oil, will give a fair idea of what may be expected in the quantity of adulterant.

If cotton-seed oil has been thickened by partial oxidation (blowing air through the heated oil), it may mislead one in arriving at a conclusion in this way, but in such a case its rapid action on metals is more pronounced.

So far as my observation has extended, all oils which have a tendency to thicken are acted upon by chloride of sulphur, and it is by means of this substance, when diluted

with bisulphide of carbon or petroleum ether, that I separate one class of oils from the other.

Cotton seed oil was at one time largely exported to Italy from this country for adulterating olive oil. This I believe is now replaced by sesame oil, and which—being an easily vulcanisable oil—is more readily detected than cotton-seed oil, with chloride of sulphur.

I may state here that oils which are affected by chloride of sulphur are unequally acted on by this reagent; but this I propose to consider in detail, at a future time.

A short time ago I was informed by a firm of oil brokers that there was no sesame oil in the market! In France sesame oil has been used for cooking purposes for some years past: there is no doubt but that it is wholesome and nourishing; this, however, hardly justifies our paying five shillings per gallon for olive oil if adulterated with sesame oil, which can be bought for about 2s. 6d. per gallon at Dunkirk.

I have at present a broker's prices-current of oils laying before me, in which olive oil is quoted at 5s. per gallon *for eating*, and 2s. per gallon for another quality of the same oil. I have known it supplied recently at 1s. 8d. per gallon.

I am painfully convinced that our oil experts are not aware of the license extended to dishonesty by too explicit a reliance on antiquated methods of research, and it is in the hope of giving prominence to this matter that I somewhat reluctantly publish this information,—I say *reluctantly*, because I am convinced dishonest practitioners will only give up one fraudulent practice for another more likely to give trouble in its detection.

The present use of cotton-seed oil and sesame oil as adulterants in the cases alluded to betrays an amount of ignorance which is simply appalling.

Castor oil, which is not regarded as a drying oil, is violently affected by chloride of sulphur; in such cases the chloride should be more largely diluted with bisulphide of carbon.

When oils are acted upon with this reagent they are converted into solid, easily pulverulent masses, from which the unconverted oil may be removed by bisulphide of carbon. On evaporating this solvent the amount of unaltered oil is obtained.

With lard oil a few precautions are necessary, but of this more will be said on a future occasion.

I can only say that anyone who has once witnessed this reaction will not readily forget the peculiar change, yet, strange to say, this reaction formed the subject of a patent by Alexander Parkes as far back as 1846.

The writer in 1871 patented the manufacture of similar compounds by melting sulphur with these oils. The resulting compound I termed "theionoline."

I am happy to say that an analyst of experience in these matters has kindly consented to work up this method of examining oils, for I am convinced that our present methods of analysis are defective, and consequently the fraudulent manufacturer is allowed to offer his "mixings" without a word being said to sober down his notions of "caveat emptor."

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, March 17th, 1887.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

MESSRS. Hugh Robert Mill, Gerald T. Moody, and Arthur Stanley were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William C. T. Beasley, Honiton School, Devon; Edwin Richardson Blundstone, B.A., 10, Wellington Mansions, Regent's Park, N.W.; Samuel Francis Burford, Halford Street, Leicester; Henry Danber, Kenmore, Waterloo Park, near Liverpool; William Gregory, Trent Valley Brewery, near Lichfield; T. O. Sandell, 1, Baron's Court Road; Leonard Owen Simmons, Fareham, Hants; Samuel Sutcliffe, Mostyn, North Wales.

The following were elected Fellows of the Society:—Messrs Harold G. Colman, James T. Cundall, Alfred J. Evans, Arthur Harden, William Houlding, Theophilus H. Redwood, George Robertson, W. H. Stanger, Patrick T. O'Sullivan.

The following papers were read:—

26. "*The Action of Heat on Nitrogen Peroxide.*" By Dr. A. RICHARDSON, University College, Bristol.

The dissociation of nitrogen peroxide has been investigated by Deville and Troost, and other experimenters, at temperatures between −12° and 180°; and it has been shown that while at low temperatures the molecule of the substance is represented by the formula N_2O_4, dissociation into nitrogen dioxide, NO_2, takes place with rise of temperature, being complete at 140°.

Experiments have been made by the author to determine the change which takes place at temperatures above 140°. On heating the peroxide at about 500° the gas becomes nearly colourless, and is found to consist of nitric oxide and oxygen; the presence of the former being indicated by the formation of the dark blue liquid which results from the interaction of nitric oxide with nitrogen peroxide when the gas is condensed, and the presence of oxygen being demonstrated by the re-kindling of a glowing match.

At a temperature at which decomposition is complete the change would be represented by the equation—

$$2NO_2 = 2NO + O_2;$$

the vapour-density of the dioxide being 0·23, that of the product is 15·3. On determining the density of the gas at temperatures between 130° and 500°, the numbers obtained were in agreement with the formula NO_2 at 140°, but as the temperature rose they more and more nearly approached that corresponding to complete dissociation. The curve representing the density of the gas at different temperatures shows that the decomposition of N_2O_4 into NO_2 is complete at 140°, and is immediately succeeded by the further dissociation of nitrogen dioxide into nitric oxide and oxygen. The form of the curve is that usually exhibited by dissociating substances, the change of density being most rapid at the temperature at which half the total number of molecules of the original substance are decomposed.

27. "*Supersaturation of Salt Solutions.*" By W. W. J. NICOL, M.A., D.Sc.

This paper contains an account of experiments on the physical constants of supersaturated and dilute salt solutions. The solutions were examined in two ways: 1st, concentration constant and temperature varying; 2nd, temperature constant and concentration varying: in this way it was possible to pass from dilute to supersaturated solutions, and to examine the change in the various physical constants. The electric conductivity, specific viscosity, and rate of expansion were examined by the first method; the specific viscosity and density by the second. In every case it was found that the curve corresponding to the non-saturated solutions was perfectly continuous with that for the supersaturated solutions. From this the author concludes that the constitution of dilute, saturated, and supersaturated solutions is the same. Supersaturation is explained by the hypothesis that the substance in solution is not the same as that which crystallises out. A supersaturated solution of sodium thiosulphate deposited crystals of the composition $Na_2S_2O_3H_2O$ when evaporated *in vacuo*, showing that the solution does not contain the pentahydrate. The author believes that the salt in solution is combined with the whole of the water, an opinion based on his experiments on vapour-pressures and molecular volumes. Colour

changes in solution are not, he believes, due to hydration, but to re-arrangements of the salt molecule similar to that which occurs in the case of chromium sulphate.

DISCUSSION.

Mr. PICKERING said that he could not agree with Dr. Nicol in concluding that a supersaturated and non-supersaturated solution have identical constitutions, or that the salt was not combined with the solvent. A large number of the physical properties of solutions, such as the volumes of the dissolved salt, the lowering of the freezing-point, &c., appear not only to afford no evidence of the existence of combination between the salt and the solvent, but would even, if taken alone, show that the radicles composing the salt itself are not combined; it was only by taking into consideration all the properties of solutions that we could obtain a correct conception of their nature. When examined from certain points of view an ordinary and a supersaturated solution would, as Dr. Nicol shows, appear to be identical, but a study of the solubility of the salt leads to very different conclusions.

Referring to the nature of solution, Mr. PICKERING said that chemists universally recognised two different forms or degrees of chemical combination, atomic and molecular, the latter being in some cases so weak that when examined from certain points of view only we could obtain no evidence of any combination at all; we should do well to consider the strong evidence which a study of minerals, alloys, isomorphous crystals, &c., afford of a form of combination less intimate even than that of our molecular compounds. The true molecules of solids and liquids, he considered, consisted in all probability of a large number of our formula molecules united together, and in the same way the true molecules of a solution would consist of aggregates of a large number of the molecules of the solvent with those of the salt, or of a definite molecular hydrate of the salt, according to circumstances, forming a unit of such complexity and instability that it would probably never exist entirely undissociated, and would therefore be affected in an apparently continuous manner by alterations in the physical conditions under which it existed (see CHEMICAL NEWS, vol. liv., p. 215).

Dr. ARMSTRONG questioned the interpretation which Dr. Nicol had given of the continuous curves by which his observations were graphically expressed. It appeared to be established theoretically that a certain definite electromotive force—over a volt—was required to electrolyse acidulated water; but actually any E.M.F., however small, was found to suffice, the reason being apparently that owing to the presence of dissolved air action took place in a contrary direction: in like manner it was probable that in many cases in which dissociation was observed, if the effect of surfaces, &c., could be eliminated, the changes would be found to take place only suddenly, and would be represented by a broken, not by a continuous, curve. The cases studied by Dr. Nicol were probably of the latter class, and if supersaturation took place gradually—part of the solution becoming supersaturated before even the whole was saturated—the curves representing the change in specific viscosity, &c., would necessarily be continuous. In discussing a problem such as that before the meeting, it was necessary to make a scientific use of the imagination and to consider the phenomena generally.

Dr. NICOL said that Professor Pickering's remarks more than ever convinced him that there was little or no difference in their views. Professor Pickering had abandoned the definite hydrate theory, and now believed in indefinite hydrate-aggregates of one molecule of salt and many hundred molecules of water. Where was the line to be drawn? He (Dr. Nicol) believed at the number of water molecules present in the solution; Professor Pickering stopped short of this, but where? As to the name to be applied to these aggregations, whether they should be called chemical or physical, he thought that according to the present use of the words the latter was the more appropriate. In reply to Professor Armstrong, Dr. Nicol pointed out that in an analogous case Wiedemann had found that the volume curve of hydrated salts exhibited irregularities long before their melting-points were reached, and that this pointed to a re-arrangement of the molecules similar to what would occur in supersaturated solutions were the hydrated salt present.

28. "*The Formation of γ-Naphthalenesulphonic Acid by Means of Sulphuric Anhydride, and on γ-Dihydroxynaphthalene.*" By HENRY E. ARMSTRONG and W. P. WYNNE, B.Sc.

By sulphonating naphthalene by means of sulphuric anhydride, both substances being intimately mixed with sand before admixture, and then vigorously shaken together, the authors have obtained a disulphonic acid which they believe is identical with that prepared by means of SO_3HCl (*Proceedings*, vol. ii., No. 27, p. 230). The sodium salt prepared from the product of the first experiment made at once crystallised in massive transparent diamond-shaped crystals of the oblique system; all attempts to prepare similar crystals from the product of the action of SO_3HCl have beeen unsuccessful, the salt from this source being always obtained in characteristic thin plates; and in a second experiment with SO_3 the sodium salt produced crystallised also in plates, distinct, however, in appearance, from those prepared from the SO_3HCl product; and this salt could not be caused to crystallise in the massive forms observed on the first occasion. Nevertheless it can scarcely be doubted that the acids prepared by the two methods are identical, as the sulphochloride from the SO_3 product has the same melting-point (182°) as, and resembles in appearance, that from the SO_3HCl product, and both yield γ-dichloronaphthalene on treatment with PCl_5; the products of the action of bromine on the two sodium salts appear to be similar; and they behave alike on fusion with potassium hydroxide.

The dihydroxynaphthalene formed on fusing γ-naphthalenedisulphonic acid with potassium hydroxide would seem to be identical with that prepared by Cléve by Griess's method from the amido-acid formed by reduction of 1 : 4′ nitronaphthalenesulphonic acid. It melts at about 250°; an alkaline solution, on warming, at once assumes a colour like that of a permanganate solution, but the colour rapidly changes to a dirty brown. The authors express the desire to reserve the right of further investigating this dihydroxynaphthalene.

29. "*α-Cyanonaphthalenesulphonic Acid.*" By HENRY E. ARMSTRONG and S. WILLIAMSON.

It being ascertained that on sulphonating the α-haloid-derivatives of naphthalene the products are the 1 : 4 homonucleal sulpho-acid together with a small amount of a heteronucleal isomer, whereas on sulphonating α nitronaphthalene and naphthalene-α-sulphonic acid the 1 : 4′ heteronucleal di-derivative is alone-formed, it became desirable to study the behaviour of other α derivatives of naphthalene containing negative radicles. α-Cyanonaphthalene was first sulphonated by means of SO_3HCl, but it was found advantageous to use fuming sulphuric acid instead; there appears to be only one sulphonic acid formed. The barium and potassium salts crystallise in different forms according to the conditions, and with different amounts of water; the most characteristic form of the barium salt is a hexhydrated modification $[C_{10}H_6(CN)SO_3]_2Ba.6H_2O$, which crystallises in long, thin, glistening plates; at low temperatures the potassium salt separates in transparent prisms, which probably belong to the oblique system, of the formula $C_{10}H_6(CN)\cdot SO_3K\cdot 3H_2O$. Both salts are dehydrated with difficulty. The sulphochloride,—

$$C_{10}H_6(CN)\cdot SO_2Cl,$$

crystallises from benzene in small glistening prisms. To judge from the result of a preliminary experiment with bromine, it is probable that the cyanosulphonic acid now described is a heteronucleal compound.

30. Addendum to Paper entitled "*An Explanation of the Laws which govern Substitution in the Case of Benzenoid Compounds.*" By HENRY E. ARMSTRONG.

In preparing the paper here referred to, having in mind the fact that the "basic" powers of nitrogen become enhanced by introduction of hydrocarbon radicles in place of hydrogen, it appeared to me not improbable that the behaviour of a compound such as dimethylaniline, for example, would not in all cases be strictly in accordance with the para-ortho-law; but I did not find any such departure recorded in the indexed literature. I have since become aware, however, that I failed to remember two recent papers, the one by A. Groll (*Ber.*, 1886, 198), the other by E. Nölting (*Ibid.*, 545). According to Groll, dimethylaniline sulphate yields on nitration at a temperature not exceeding 5°, besides the paranitro-derivative, no less than 80 to 85 per cent of *meta*nitrodimethylaniline; diethylaniline behaves similarly. Nölting not only confirms these statements, but adds that ethylaniline sulphate also yields a large proportion meta-derivative; and that on nitrating ethylparatoluidine sulphate, the *meta*nitro-derivative, $NHEt : NO_2 : Me = 1 : 3 : 4$, is exclusively formed; whereas, according to Wurster, the bromodimethylaniline obtained by brominating dimethylaniline dissolved in acetic acid is the *para*-modification; and, according to Beilstein and Kuhlberg, paracetoluide yields only the *ortho*nitro-derivative, $NHAc : NO_2 : CH_3 = 1 : 2 : 4$. The facts appear to materially strengthen my argument that the meta-derivatives are formed from an *additive* compound resulting from the association of the reacting molecule with the radicle R' of the parent compound.

In further support of the argument underlying my paper (*Trans.*, 1887, 258), that the formation of an additive compound precedes that of the substitution derivative, I may take the opportunity to point out that on this assumption it is not difficult to understand that, for example, two hydrogen-atoms in ethylic acetoacetate,—

$$Ac{\cdot}CH_2{\cdot}COOEt,$$

are not both immediately displaceable by sodium; probably an additive compound with sodium ethoxide is first formed, which becomes resolved into alcohol and acetosodacetate,—

$$Ac{\cdot}CH_2{\cdot}CO_2Et + NaOEt = Ac{\cdot}CH_2{\cdot}(CO_2Et{\cdot}ONaEt) = Ac{\cdot}CHNa{\cdot}CO_2Et + EtOH;$$

owing to the influence which the sodium exercises on the contiguous CO_2Et group, this is no longer capable of uniting with sodium ethoxide, and only recovers the power of so doing on displacement of the sodium by a hydrocarbon radicle.

31. "*The Transformation of Citric Acid into Pyridine-derivatives, and on the Constitution of Pyridine.*" By S. Ruhemann, Ph.D., Jacksonian Demonstrator in the University of Cambridge.

Holmann and Behrmann have shown that citramide is converted by heating with sulphuric acid into citrazinic acid, the dihydroxypyridinecarboxylic acid, in which both hydroxyls are in ortho-positions to the nitrogen-atom, the carboxyl being in the para-position. The author finds that the formation of the pyridine-derivative takes place even at ordinary temperatures if ethylic aceto-citrate be mixed with strong aqueous ammonia, and the mixture allowed to stand several days; dilute chlorhydric acid then precipitates citrazinamide. The production of a pyridine-derivative in this manner is a strong argument, he thinks, in favour of Riedel's contention that the nitrogen-atom in pyridine is in connexion with the carbon-atom, which relatively to it is in the para-position; and in further support of this view he states that no condensation takes place if methylamine be substituted for ammonia, there being in this case no available hydrogen-atom associated with the nitrogen-atom to separate with the hydroxyl, and thus permit of the union of the nitrogen-atom with the para-carbon-atom. Incidentally it is mentioned as an indication of the mobility of the acetyl-group that if ethylic aceto-citrate be treated with phenyl hydrazine, the acetyl-derivative if the latter is formed; ethylic acetomalate and diacetotartrate behave similarly.

32. "*Silver containing Bismuth.*" By William Gowland, A.R.S.M., Chemist and Assayer of the Imperial Mint, Osaka, Japan, and Yoshimasa Koga, Assistant Assayer.

An account is given of assays and metallurgical experiments made with the object of determining the effects produced by the presence of small quantities of bismuth on the ductility of silver, and on the uniformity of composition of silver bullion when in ingots of the form and size ordinarily met with in commerce. It is found: α. That when silver is obtained from copper containing bismuth by the liquation process with subsequent cupellation of the argentiferous lead, it contains part of bismuth which was present in the copper; β. That this silver is brittle even when containing bismuth in but small amounts; γ. That ingots of such silver are not uniform in composition throughout their mass, the parts which have solidified last being richer in silver than the others; δ. That when coinage bars of 900° millesimal fineness are prepared from it, they cannot be rolled without special treatment, and even then are hard and unsuitable for mintage.

The Anniversary Meeting will take place on March 30, at 8 p.m.

At the next Ordinary Meeting, on April 7, the following paper will be read:—

"Researches on the Constitution of Azo- and Diazo-derivatives. Diazoamido-compounds (Part II.)," by R Meldola, F.R.S., and F. W. Streatfeild.

PHYSICAL SOCIETY.

March 12th, 1887.

Prof. G. Carey Foster, Vice-President, in the Chair.

Mr. Shelford Bidwell described some experiments which seem to show that the electrical resistance of suspended copper and iron wires alters with the direction of the testing current. The apparatus used consisted of a metre bridge with coils of 100 ohms in the gaps adjoining the standard wire, the other two arms being two suspended wires united at the top, to which point one terminal of the galvanometer was joined. A commutator placed in the battery circuit served to reverse the testing current.

When a wire is suspended vertically the stress increases from below upwards, and the author believes the observed effects due to the absorption of heat by the current as it passes from a stretched towards an unstretched part of a copper wire, and the evolution of heat when it passes from an unstretched towards a stretched part. As the apparatus was arranged the current passed up one wire and down the other, heating the one and cooling the other, thus disturbing the position of balance. If iron wires are used the heating and cooling effects are reversed.

Prof. S. P. Thompson suggested loading the wires at different points, in order to vary the stress without using such long wires; and Mr. C. V. Boys thought that still shorter wires could be used, by joining the ends to a revolving spindle and stretching them by centrifugal force.

"*On a Lecture Experiment in Self-Induction.*" By Mr. Shelford Bidwell.

A telephone is placed in series with the secondary coil of an induction-coil, and another coil whose self-induction can be varied by inserting a core of iron wires or another coil, or both. The effect of introducing the iron core is very marked, reducing the sound enormously. If a coil of wire containing an iron core be inserted, the effect of short-circuiting the coil increases the sound in the telephone.

The same author also described and showed an experiment due to Dr. Fleming, in which a disc of copper

inclined at an angle of 45° to the axis of a coil of wire, and suspended bifilarly, is deflected by passing an undulatory current round the coil.

In explanation of the former experiment Dr. Fleming wrote down the formula for the effective resistance and self-induction of a circuit near another closed circuit, which show that the former is greater and the latter less for undulatory than for steady currents. He had not arrived at any satisfactory explanation of the deflection of the copper disc.

Prof. Ayrton exhibited a tuning-fork worked electrically, in which the pitch could be varied by altering the self-induction of the circuit, or by varying the position of the make and-break screw.

Mr. C. V. Boys referred to his experiments, published in 1884, on the impulse given to metal discs suspended in a magnetic field, whose strength is suddenly changed, as being of a similar character to that described by Mr. Bidwell, and suggested the use of aluminium instead of copper in future experiments, owing to its conductivity for the same weight being greater.

Prof. Thompson said he had recently used a similar apparatus to that described by Mr. Bidwell as an illustration of the effect of self-induction, and pointed out the uses of self- and mutual-induction in multiplex telegraphy and telephony.

As an explanation of the deflection of the copper disc by alternating currents, Prof. Foster thought it possibly due to its initial position being that of maximum sensibility, and therefore each impulse had less effect then the preceding one.

Mr. W. M. Mordey mentioned a simple arrangement for varying self-induction used by Mr. Ferranti to control the power of incandescent lamps worked by alternating currents; and Prof. Ayrton described a closed magnetic circuit of great self-induction, used to protect voltmeters on the telpher line at Glynde from disastrous inductive effects produced by breaking the locomotive circuit.

Referring to tuning-forks, Mr. Bosanquet thought some self-induction was necessary in order that the current should act to the best advantage in attracting the prongs at the proper instant.

Further remarks were made by Mr. Boys and Prof. Perry.

"*On a Lecture Experiment to show that Capacity varies Inversely as the Thickness of the Dielectric.*" By Profs. W. E. Ayrton and John Perry.

The authors consider it easy for students to see that, other things remaining constant, capacity is proportional to area. Taking this as proved, a condenser is arranged such that the area, A, of the insulated inner coating varies as the thickness, t, of the dielectric, and the potential difference between the coatings is found by experiment to be constant. Then, since—

$$\text{Capacity} = \frac{\text{Quantity}}{\text{Potential}},$$

and both the latter being constant, therefore the capacity of the condenser is constant. But by the construction of the apparatus $\frac{A}{t}$ is constant, and it is assumed that capacity varies as A; therefore capacity must vary inversely as t.

"*Note on Magnetic Resistance.*" By the same Authors.

Two iron rings, about 6 inches diameter, made from the best Swedish iron, about ½-inch diameter, were wound with insulated wire in two halves, so that a current could be sent round either or both halves, and the resulting induction measured by the throw of a ballistic galvanometer placed in series with a few convolutions of wire wound round the outside of the main winding. One of the rings was continuous, and the other had a small air-space of about 0·8 m.m. in a plane perpendicular to that of the ring and passing through its axis, as if the ring had been cut by a saw. The primary object of the experiments—which were made by Messrs, Aldworth, Dykes, Lamb, Robertson, and Zingler, of the Central Institution—was to determine whether there was any appreciable "surface magnetic resistance" The results do not show any such resistance; and the relative resistance of air and iron, as calculated from the unsaturated parts, are about as 1200 to 1, a number agreeing fairly well with those obtained by other experimenters. From this the authors conclude that for small distances magnetic resistance of air is proportional to length. When the magnetising current was passed round the one-half of the divided ring on which the test coil was wound, a greater induction could be obtained than by any other way of magnetising, and this the authors do not attempt to explain.

Mr. Bosanquet said he had always found greater inductions obtainable in the middle of bar electro-magnets or open magnetic circuits than could be produced in closed magnetic circuits, and thought the above observations confirmed his own results.

A discussion followed, in which Mr. C. .V Boys, Mr. W. M. Mordey, Mr. Bosanquet, and Prof. Perry took part.

On account of the late hour the reading of a "Note on Dynamo Machines and Motors," by Profs. Ayrton and Perry, was postponed till the next meeting

NOTICES OF BOOKS.

Address to the Agricultural and Horticultural Association, Limited. By Ed. O. Greening. 1887.

In commenting on some very desponding remarks on the subject of British Agriculture, recently made by Mr. C. S. Read, in which he declares that, on scanning the whole social horizon, he can see no hope from any quarter. Mr. Greening boldly states that things are not so bad as some people would have it believed; scientific men may have blundered in their advice to farmers, engineers have sometimes made uneconomical machines, but, he asks the British landowners and farmers:—Have you really exhausted all the resources of your knowledge, your experience, your powers? In reply, Mr. Greening, in the first article of the accompanying pamphlet, hopes he has clearly shown how members of this Association, now entering on its twentieth year, can obtain exactly the fertilisers required to grow the greatest crops at the smallest cost, and with absolute immunity from danger of exhausting the soil.

The title selected for the above-mentioned article, which accompanies this address, is "Does it Pay to Use Complete Manures?" This question is in reality a very simple one, though it is generally complicated by other questions which have nothing to do with it; it can, however, be easily solved by answering the following:—

1st. What is the cost of the manure and it application?
2nd. What is the increased value of the crop?

Last year one of the members of the Association, Mr. Bellairs, made some very careful experiments on manuring potatoes; the soil was poor, and moderately light, frequent showers favoured the dissolving of the artificial manures, and during the first two months the superior growth of one plant showed the advantage of manuring *up the furrows* instead of on the surface, as is so frequently advocated in these days. The weights of the manures applied and the potatoes yielded are given, and show a balance in favour of artificial manure of £12 per acre. The conclusions from these experiments are:—

1. That there is a large profit on the use of complete potato manure of scientific proportions.

2. That in these experiments the highest result (with one exception) were obtained with the use of No. 6 manure (as supplied by the Association) mixed with salt, gypsum, and ashes in the proportions stated.

3. The exception was in favour of good dung ploughed in, with a top-dressing of No. 6, but as the cost and quality of the dung was unknown, the comparative profit or loss of this treatment cannot be accurately judged.

4. Neither sulphate of potash alone, or gypsum and salt, produced such favourable results as the complete manure No. 6, though the combination of the two latter was distinctly advantageous.

5. Better results were obtained by applying the manure as a top-dressing when the potatoes were planted, than at a later period.

6. The best results of all were obtained by sowing the No. 6 with salt and gypsum up the furrows and not on the top.

A number of letters are quoted from different users of these manures, all testifying to their value; one gentlemen states that "one drill, manured twice by mistake, yielded, at an extra cost of 2s. 4d., 3 cwt. more potatoes than the adjoining drill, showing that, even at the present low values, there would be more profit by doubling the manure than by using the amount prescribed. From these und other results here given, it is clear that high manuring with complete manures pays better than stinting the outlay. An average of thirty years continuous wheat-growing on the same land shows that unsuitable manure costing 40s. per acre is almost money thrown away; that nitrate of soda worth £2 15s. per acre gives an extra profit of £3 10s., and that a complete manure costing £4 10s. produces an increased profit of £7 17s. 6d. per acre. We further find that, in a bad year, complete manure pays an extra profit of £2 10s. per acre, on an average of years £3 7s. 6d., and in a good year it will pay £4 10s., calculating the wheat at its very lowest value. The moral of this is, as Mr. Greening says, that instead of ceasing to use manure in good seasons and relying upon the weather, a wise agriculturist should double his outlay at such a time, and double his gains while circumstances give him the golden opportunity.

The Graphical Representation of the Relation between Valence and Atomic Weight. By C. J. Reed. 1886.

In these days, when the relations between matter and matter, and even the primal composition thereof, is attracting considerable attention from scientific men of all classes, any fresh information or ideas bearing in any way on the subject are sure to be carefully considered.

Mr. Reed has approached the question from a mathematical point of view, and he starts with the three following hypotheses, which were first announced, though in a different form, by Mr. O. C. Johnson in the Chemical News, vol. xlii., p. 51.

Hypoth. I. *The valence of an atom is its capacity for electro-polarity.*

Hypoth. II. *The polarity of an integrant molecule is always zero.*

Hypoth. III. *Positive and negative changes of polarity are always contemporaneous and equal.*

All the atoms in a molecule are to be considered as polarised, one-half the atoms (measured in *valence*, not in numbers) positively, and the other half negatively; an atom is *neutralised* when it is united with one or more atoms having the same degree of polarity but of opposite sign, neutralisation meaning opposition, and not that the polarity is destroyed; thus, two atoms united into a molecule may be compared to two permanent magnets united by their opposite poles, forming a molecule which would present no external polarity. Mr. Reed gives a very clear illustration of this conception, but unfortunately it cannot be followed without having reference to the accompanying diagrams.

In Part II. are given the atomic weights and observed valence of the elements, and the principal compounds in which those valencies occur. In compounds which cannot be electrolysed the more basic elements are considered electro-positive and the more acidic electro-negative.

Part III. deals with the graphical representation of the relations detailed in Part II., but in the absence of a diagram we cannot make this perfectly clear; the manner of plotting is, however, as follows:—Two straight lines meet at right angles at zero, the vertical line representing valence ×10 and extending to 40 below zero, and the horizontal line representing atomic weight, a point is located on the plane for the maximum, minimum, and characteristic valence of each element, and nearly all these points are found to lie on a double series of parallel lines, the successive pairs of which are separated by equal distances, the deviations from these positions is so slight as to be barely noticeable on the scale used; after considering this diagram and pointing out some periodic and recurrent combinations, Mr. Reed concludes that "*saturation-valence is an equicrescent rotatory function of atomic weight*," and in order to represent this idea graphically he locates the points on the surface of a cylinder instead of on a plane. He next points out that he has considerable grounds on which to base the conclusion just quoted, which he claims can hardly be a coincidence from the fact that it unites not less than fifty chemical elements by so simple a relation between valence and atomic weight; whether this conclusion is or is not the expression of a natural law he leaves for others to decide after mature consideration, but we must admit that on first sight there seems to be very reasonable grounds for the assumption.

CORRESPONDENCE.

METHOD OF PREPARING GRAPHITOIDAL CARBON FOR ELECTRICAL INCANDESCENCE.

To the Editor of the Chemical News.

Sir,—Under this heading in your last issue Mr. H. N. Warren describes a method for preparing carbon filaments for incandescence lamps by the passage of an electric spark through coal-gas, and the consequent decomposition of the gas with deposition of carbon upon one of the electrodes. The method, however, is not novel, for in November, 1882, it was patented (British Patent No. 5373 of 1882) by myself in conjunction with Messrs. J. M. Boullon and Isaac Probert; and three years later was apparently re-patented by Mr. Alexander Bernstein (British Patent No. 13,036 of 1885).

The fact that a deposit of carbon can be obtained upon one of the electrodes during the electrolysis of a carbonaceous gas is of course much older than either of these patents. Everyone who has used a Hofmann's tube for showing the volumetric composition of marsh-gas is familiar with the partial or complete bridging over of the spark space which occurs during the progress of the experiment.—I am, &c.,

Alfred W. Soward.

March 21, 1887.

RELATION OF THE CHEMICAL CONSTITUTION OF INORGANIC COMPOUNDS TO THEIR PHYSIOLOGICAL ACTION.

To the Editor of the Chemical News.

Sir,—In the Chemical News (vol. lv., p. 110) is an article on this subject, stated to be a report of a paper I read before the University College Physical and Chemical Society. The paper I read before the Society was a different thing altogether. Its object was to point out some of the defects in our methods of scientific teaching, particularly as regards the neglect of the historical development of the different sciences, and also to emphasize the advantages of such societies as the one I was addressing, from their tendency to counteract the evils

resulting from the too specialised pursuit of any one science. The article published in the Chemical News contained merely some extracts from a paper read before the Chemical Society in December, and which were introduced into my address partly from some historical reminiscences connected with my earlier experiments which were made in the same locality just half a century ago; but principally as, in reviewing the criticisms that had been made on my work, I had an opportunity of pointing out some striking examples of the evils of a too specialised pursuit of any one branch of science, which evils it was the object of the Society I was addressing to counteract.

The paper as published in the Chemical News is very analogous to the play of "Hamlet" with Hamlet left out. As I had no opportunity of seeing a proof I would correct two errors which occur in the paper: one in relation to the relative quantities of the reagents, page 111, where the quantity for Mg should be 0·080 instead of 0·030; and another, on the same page, where Schmeideberg should be substituted for Schmerdehery.—I am, &c.,

James Blake.

[Want of space prevented our publishing the paper in full; we gave, therefore, only the chemical part.—*Ed.* C. N.]

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 9, February 28, 1887.

Phosphorescence of Calcium Sulphide.—Edmond Becquerel.—Inserted in full.

Red Fluorescence of Alumina.—Lecoq de Boisbaudran.—It has been already stated that alumina, after strong ignition, though it gives a bluish fluorescence in a vacuum, gives a red colouration in the phosphoroscope. The writer, however, thinks that this observation does not subvent his hypothesis of the presence of chrome as necessary for the production of the red fluorescence of alumina.

Coefficients of Chemical Affinity.—P. Chroustchoff and A. Martinoff.—Berthollet, as it is well known, announced the following rule: the chemical actions of bodies are simply proportional to the numbers of their equivalents present. Subsequent researches have led several chemists to put forward much more complicated laws to which the phenomena of transformation may be subject. Berthollet's rule has been re-modelled by the introduction of certain coefficients, called coefficients of affinity, which are alleged to give the measure of the affinity peculiar to different bodies. The researches of M. Berthelot have, however, proved that one of the forms of these coefficients of affinity, that known as the *avidity* of acids for bases, does not possess the character of a true constant. These conclusions have led the authors to undertake the experimental revision of one of the methods which have been thought applicable for determining these coefficients. From the results thus obtained they infer that the primitive composition of mixed precipitates formed by a mixture of salts in equal numbers of equivalents approaches a symmetrical distribution with about 50 per cent of each of the insoluble salts. The phenomenon of precipitation is constituted in the like cases by the superposition of two distinct phases, *i.e.*, a perfectly mechanical distribution according to the initial chances of meeting of the three bodies mixed, and a secondary transformation (simultaneous or consecutive) of the precipitates when once formed by the surrounding liquids; this secondary reaction being produced with a variable rapidity. Neither the initial composition nor the final composition (stable equilibrium) of the precipitates can give the coefficients of chemical affinity. Hence constants characteristic of affinity cannot be elaborated by the method of simultaneous precipitation.

Characters of Debilitation experienced by Diastase if Submitted to the Action of Heat.—E. Bouquelot.—Weakened diastase, even if used in excess, has lost the power of carrying the decomposition of starch to its ultimate limit. Yet this same diastase effects the first phases of the reaction as rapidly as natural diastase. It is suggested as possible that there may exist in natural diastase two or more soluble ferments in a state of mixture, and that an elevation of temperature destroys them successively.

The Earths of Cerite.—Eug. Demarçay.—The author has formerly shown that the absorption band $\lambda = 417$ attributed to samarium does not belong to the same body as that which furnishes the band $\lambda = 400{\cdot}7$. He has since pursued the fractionations, and has arrived at results which he now lays before the Academy. As regards samarium he confirms his former results, and adds that the band $\lambda = 417$ does not belong to the body which furnishes the blue bands $\lambda = 480$, $\lambda = 463$; concerning the common or distinct origin of the three bands $\lambda = 400$—480—463. Among the products of these fractionations there are earths very rich in praseodyme, and others in which it is absent. The fractions comprised between pure praseodyme and neodyme present the band $\lambda = 469$ equal in strength to $\lambda = 444$ (the latter attributed by Auer von Welsbach to praseodyme), but with an intensity greater than that which it presents in earths consisting of almost pure praseodyme. Hence this band would seem to represent a distinct body. The author has not observed with certainty a corresponding variation in the other bands of praseodyme, nor in those of neodyme. The bands $\lambda = 476$ and $\lambda = 462$ seemed to vary simultaneously. The methods used for these fractionations are precipitation with dilute ammonia, oxalic acid in very acid solutions, crystallisation of the ammoniacal nitrates, and the precipitation of the sulphates and double potassium sulphates by alcohol.

On Zinc Ferrite: The Artificial Production of Franklinite.—Alex. Gorgen.—The author gives methods for preparing zinc ferrite, and compares this artificial product with the natural mineral franklinite.

Incompatibility of Nitrates and Superphosphates.—A. Andouard.—A mixture of mineral superphosphate and soda saltpetre contained, when prepared, at the end of May, 1886, 6 per cent of nitric nitrogen. By July 12 it had gradnally fallen to 3·78 per cent. Other mixtures, both on the large and the small scale, gave corresponding results. This loss was observed with bone superphosphates as well as with that from phosphatic minerals. The presence of sulphate of ammonia and, apparently, of nitrogenous organic matter, does not retard this waste. The free phosphoric, sulphuric, and hydrofluoric acids present displace the acid of the nitrate, which escapes either as such or, after being gradually reduced by the oxidisable substances present. Hence it is an error to associate nitrates with superphosphates in manures. Decomposition can be retarded only by employing the nitrate in coarse fragments, which of course interferes with its uniform distribution in the soil.

Cause of the Changes observed in Blood in Contact with Air, Oxygen, and Carbonic Acid.—A. Béchamp.—The changes with take place in blood, whether in contact with oxygen or carbonic acid, are effected only by means of the activity of the microzymas present.

The Deposits of Tin from a Geological Point of View.—M. Reilly.—The author shows that the chief deposits of tin lie on or near a great circle which he calls the axis of Sumatra.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., (Part First), February, 1887.

History of Californian Borax.—A. Robottom.—From the CHEMICAL NEWS.

Studies on Mordanting Wool.—MM. Liechti and Schwitzer.—Translated here from the *Journal of the Society of Chemical Industry.*

Determination of Nitrogen according to Kjeldahl.—After giving the opinions of a number of chemists the author concludes by saying that Kjeldahl's method is likely to do good service for the analysis of manures, articles of food, forages, and the majority of organic nitrogenous substances. It is not applicable to the amines with aromatic nuclei. The results are also uncertain if the substance contains much nitrate. It is therefore applicable for all cases where the process of Will and Varrentrap is commonly used, and it has, in comparison with the latter, the advantage of being quicker, easier, and more economical.

A Laboratory Accident.—E. Divers.—From the CHEMICAL NEWS.

Determination of Empyreumatic Oils in Spirits.—A. Stützer and C. Reitmar.—The authors' method is based upon the influence of ethereal oils upon the height to which water and alcohol ascend in capillary tubes.

Phenazine and its Derivatives.—From the *Berichte der Deutsch. Chem. Gesellschaft.*

Communications on Germanium.—Clemens Winkler.—Already noticed.

Certain Simple Bodies, probably New.—Al. Pringle.—From the CHEMICAL NEWS.

Synthesis of Aromatic Bodies, effected by Means of Aluminium Chloride.—This extensive memoir bears no author's name. The results may be summarised as follows:—The dyssymmetric dibenzyle and diphenylethylene resulting from the reaction of the isomeric dibromethylenes in presence of aluminium chloride are formed without an intermolecular displacement of the atoms taking place, and they have consequently the same constitution as the dibromethylenes from which they are derived. The synthesis of anthracene effected by the aid of acetylene tetrabromide, of benzine, and of aluminium chloride renders the hypothesis probable that in anthracene the two atoms of carbon occupying the *meso*-position are connected together. Dimethylanthracene, melting at 225°, being obtainable by the reaction of tetra-brom-anthracene upon benzine in presence of aluminium chloride, we must admit that there are two methyl-groups fixed upon the benzinic nuclei. Aluminium chloride possesses not merely the power of splitting the lateral chains of the methylbenzines and ethylbenzines, but it also determines the removal of the split chains from one molecule of the hydrocarbon to another. In this migration the same methyl-benzines may be formed by the addition of the methyl-groups to the less methylated benzines, which are formed by the loss of these groups in the more methylated benzines. Tetraphenylmethane obtained synthetically by the reaction of β-styrolene bromide, stilbene bromide, or tolane bromide upon benzine in presence of aluminium chloride is identical crystallographically with the tetraphenylethane obtained from succinic acid and benzhydrol, chloride of benzhydrol, benzophenone, β-benzpinacoline, and tetraphenylethylene. Hitherto, in consequence, we know only one of the two isomeric tetraphenylethanes, which are theoretically possible. The separation of bromine in the tetra-brom-ethanes and vinyle tribromide, treated with aluminium chloride in presence of benzol, is proved indirectly by the presence of benzine bromide among the products of the reaction. By the reaction of ethylidine bromide, ethylidine chloride, and vinyle bromide upon benzine in presence of aluminium chloride, we obtain synthetically, along with dissymmetric ethylbenzine and diphenylethane meso-dimethyl-anthracene hydrate. Ethylidene chloride, toluene, and aluminium chloride yield, along with dissymmetric ethyl-toluene and ditolylethane, hydrated tetra-methyl-anthracene.

Academy of Medicine: Salicylic Acid.—After a prolonged discussion it was decided that even small doses of salicylic acid and its derivatives, if often repeated, may occasion serious derangements of health in elderly persons, and in all in whom the digestive and the urinary organs are not in perfect order. Hence the addition of salicylic acid and its derivatives to articles of food and drink cannot be authorised.

Industrial Society of Mulhouse.—Chemical Committee, November 10, 1886.—A sealed paper which had been deposited by M. Weingaertner was read. It relates to the preparation of phenyl-methoxyquinizine.

H. Kœchlin mentioned that in dyeing turkey reds he has been able to dispense for the last ten years with the clearing process with soap-lye under pressure, using merely water or steam, and suppressing the sulpholeic preparations which precede this process. He adds to the dye beck stannic acid, obtained by precipitating the nitromuriate of tin with sodium carbonate.

Session of December 8, 1886.

M. Oscar Scheurer gave an account of his experiments on the fixation of iron mordants in presence of phosphorous acid and of a copper salt.

Contributions to the Chemical Analysis of Iron, Steel, and Cast-Iron.—An account of ths proceedings at a meeting of Russian iron-masters. As regards the determination of carbon, the method of Eggertz is considered as deffcient in accuracy.

The Quantity of Cinchonidine contained in the Quinine Sulphate of Commerce.—O. Hess.—An acrimonious reply to a paper by M. de Vrij.

Detection of Wheat-Flour in Chocolate.—Dr. G. Pennetier.—A microscopic method.

MEETINGS FOR THE WEEK.

MONDAY, 28th.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Machines for Testing Materials, especially Iron and Steel.' Prof. W. C. Unwin, F.R.S.
TUESDAY, 29th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Function of Respiration, by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8. "Colonial Wines," by Richard Bannister.
WEDNESDAY, 30th.—Society of Arts, 8. "Electric Locomotion," by A. Reckenzaun.
—— Chemical, 8. (Anniversary).
THURSDAY, 31st.—Royal, 4 30.
—— Royal Institution, 3. "The Science of Thought, by Prof. F. Max Müller, M.A., LL.D.
FRIDAY, April 1st.—Royal Institution, 9. "Light as an Analytic Agent," by Professor Dewar, M.A., F.R.S.
—— Geologists' Association 8.
SATURDAY, 2nd.—Royal Institution, 3. "Sound," by the Right Hon. Lord Rayleigh.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Hard Water and Stone.—Since my last communication I have been informed by a medical man that stone is most prevalent in places of least rainfall, and *vice versa*, *e.g.*, Norfolk and the Lake District. In India stone is of common occurrence.—SM.

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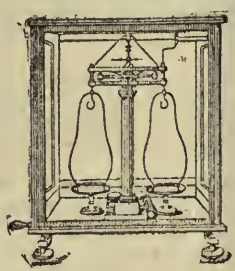

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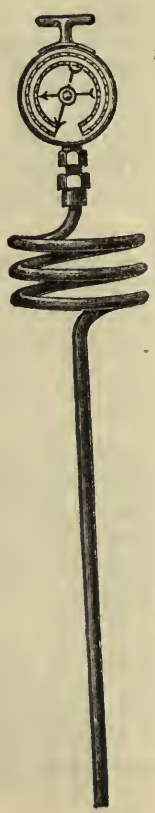

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ST. PAUL'S SCHOOL.—An Examination for filling up about Four Vacancies on the Foundation will be held on the 21st April, 1887.—For information apply to Mr. S. BEWSHER, Bursar, St. Paul's School, West Kensington.

THE CHEMICAL NEWS.

VOL. LV. No. 1427.

ON THE

BEHAVIOUR OF ALKALINE SOLUTIONS OF PHENOL-PHTHALEIN IN THE PRESENCE OF ALCOHOL.

By HARRY NAPIER DRAPER, F.C.S., and CARTER DRAPER.

(Concluded from p. 134.)

PART II.—PHENOL-PHTHALEIN WITH ALCOHOL, AND POTASH OR SODA.

As the results obtained with ammonia appeared of sufficient interest to render desirable an examination of the behaviour of phenol-phthalein with potash and soda in the presence of alcohol, a number of preliminary and parallel observations were made, which demonstrated that both bases present, though in different degree, the same phenomena. Potash was selected for the enquiry, and it is to be understood that the experiments cited in the following notes were made with potassium hydrate.

The standard solution of phenol-phthalein employed was the same as that used in the ammonia experiments, and the potash and soda solutions contained respectively 1 grm. of KOH and of NaOH in 100 c.c. of absolute alcohol.

One c.c. of the phenol-phthalein solution and 1 c.c. of the potash solution were mixed with 20 c.c. of alcohol in a beaker. Such a solution containing ammonia instead of potash would have become instantly colourless, or rather would not have become coloured at all, but this remained deeply red. The colour, however, gradually faded, and after a short time the liquid was colourless. To determine the time occupied in bringing about the decolouration several experiments were made, and the mean result of these showed it to be, at 15° C., forty-five minutes.

It was at first assumed that the reaction here was analogous to that with ammonia,—that is, that the anhydrous phenol-phthalein salt of potassium being probably colourless, any water present in either the phenol compound or the potash was gradually dissociated by the action of the alcohol.

That, indeed, either the anhydrous potassium salt of phenol-phthalein is colourless, or that in the absence of water no combination takes place, may be demonstrated by impregnating white bibulous paper with a dilute solution of potassium hydrate, and then, after careful drying, moistening it with alcoholic phenol-phthalein. The paper thus prepared remains practically colourless. For obvious reasons this experiment requires careful manipulation, but may be more easily made if a watery solution of the carbonate be substituted for the alcoholic solution of the hydrate. In either case the faintly tinted paper becomes, upon moistening with water, intensely coloured.

But that this assumption was not tenable, soon became evident. In the first place, addition of water to the decolourised alcoholic solution did not restore the colour. Secondly, it was not probable that the small quantity of water present could—in the presence of so large an excess of alcohol—effect so deep a colouration of the liquid. Thirdly, a further addition of alcoholic solution of potash to the decolourised liquid restored its colour.

The next step taken was the substitution of water for the alcohol. A mixture consisting of 1 c.c. phenol-phthalein solution and 1 c.c. of the potash solution, with 20 c.c. of water exposed in an open beaker, had not become colourless in three days,* and in this case, also, the colour was restored by further addition of potash. There was thus indicated a marked difference between the behaviour of alcohol and that of water, which led us to suppose that if the quantity of alcohol added were increased, the decolouration might be more rapidly effected; but many experiments with varying quantities of alcohol afforded no support to this view.

When a phenol-phthalein-potash-alcohol solution was contained in a quite filled and closed flask the colour remained permanent. This pointed to atmospheric action as the cause of the colour destruction. To ascertain if it were due to oxidation the following experiments were made:—

The solution was exposed for three days in an atmosphere of pure oxygen without undergoing any loss of colour.

To 20 c.c. of the coloured liquid there were added at intervals 32 c.c. neutral hydrogen peroxide of 10 per cent. After three days it had become nearly colourless.

To a trace of potassium carbonate dissolved in water excess of alcohol was added, and then phenol-phthalein. The colour of this solution was at once destroyed by hydrogen peroxide.

Ethereal solution of hydrogen peroxide acted in the same way, but more rapidly.

The introduction into solutions decolourised by hydrogen peroxide of a copper-zinc couple restored the colour after some hours, but the action of a palladium-hydrogen couple was without effect. Dry and carefully purified hydrogen passed for some time through the liquid was equally ineffective.* It was thus evident that the colour restoration brought about by the copper-zinc couple was due to the formation of zinc oxide, which we have found to be, when recently precipitated, sufficiently soluble in water to give a marked colour reaction with phenol-phthalein.

When the solution decolourised by exposure to air is boiled for a few minutes in an open tube its colour returns, and when again cooled it becomes colourless.

In a sealed tube no restoration of the colour takes place, even after prolonged heating at 100°. If again an open tube, in which, after boiling, the liquid has become coloured, be at once closed, the latter remains coloured for a short time, but afterwards becomes colourless.

It being now sufficiently probable that the decolouration was due to atmospheric carbonic acid, the enquiry took this direction.

In an atmosphere of hydrogen, the red solution after forty-eight hours still remained red.

In air, which had been carefully freed from carbonic acid, there was in twenty-four hours no decolouration.

When dry air was rapidly aspirated through the liquid it became decolourised in thirteen minutes; when the air was passed through potash tubes, and the same rate of aspiration employed, seventy-five minutes were required. From other experiments it was found that the time required for decolouration was directly as the rate of aspiration, indicating of course greater or less absorption of carbonic acid by the interposed potassium hydrate.

A few drops of water saturated with carbonic acid produced immediate decolouration of the liquid.

If 1 c.c. each of the solutions of phenol-phthalein and potassium hydrate be mixed with 20 c.c. of alcohol, through which a current of carbonic acid has been passed, the colour is instantly destroyed; but alcohol which has been previously boiled may, on the contrary, be added in large quantity without causing decolouration.

In the experiments with ammonia it has been noted that the quantity of unboiled alcohol required to effect decolouration was notably less than of alcohol which had been boiled; but in the case of the fixed alkalies no dissociating action seems to be exerted by alcohol, and the loss of colour appears to be wholly due to the absorption of carbonic acid by the alcoholic solution.

* In another experiment eleven days were required to effect decolouration.

* The destruction of the colour by neutral hydrogen peroxide is somewhat ambiguous, but we have not pursued the reaction further.

It has been already shown that watery solutions require for decolouration a very much longer time than those in alcohol. That decolouration in an aqueous solution should occur at all, can indeed only be due to the ultimate formation of an alkaline bicarbonate, because if the action of the absorbed carbonic acid stopped short at the formation of carbonate the colour of the solution would remain unchanged.

The greater rapidity of decolouration of an alcoholic solution is due to two causes: firstly, to the larger solubility of carbonic acid in alcohol than in water. According to Fehling*—

1 vol. water	at	0° C.	dissolves	1·79	vols. CO_2.
1 ,, ,,	,,	14° ,,	,,	1·03	,,
1 ,, alcohol	,,	0° ,,	,,	4·32	,,
1 ,, ,,	,,	18° ,,	,,	3·04	,,

Secondly, to the complete insolubility of potassium carbonate in cold alcohol, for such weak solutions as we have employed become very rapidly carbonated when freely exposed to the atmosphere.

So that the absorption of carbonic acid to the extent of formation of a bicarbonate (a necessary condition for the decolouration of an aqueous solution) is not necessary where alcohol replaces the water. Indeed if the proportion of potassium hydrate be about five times greater than that employed in the above experiments, the solution, which in this case of course requires a much longer time for decolouration, deposits a precipitate of pink-tinted carbonate in a perfectly colourless liquid. Finally, the carbonate itself becomes colourless. If, however, before this decolouration takes place, a portion of the coloured carbonate be removed from the liquid and dried, it loses its colour. That the supernatant liquid in this case contains potassium bicarbonate, and not carbonate, may be demonstrated by a careful application of the mercuric chloride test.

Potassium bicarbonate is, according to Gmelin,† soluble in 1200 parts of alcohol, and it is upon this fact that the phenomena observed on heating the decolourised alkaline phenol-phthalein alcoholic solution depend. In a sealed tube this may be heated without change, but on boiling in an open tube it loses carbonic acid, and in a few minutes the colour is restored. If the solution be now cooled the colour disappears, and that this is due to re-absorption of carbonic acid is proved by the fact that if the cooled tube be again sealed the colour is no longer restored on heating to 100°. But if, on the contrary, the tube be sealed as rapidly as possible while the contained liquid is still hot and coloured, the latter becomes, as before, colourless on cooling, but *the colour is at once restored when it is again heated.*

The explanation of this reaction is due to the—we believe—hitherto unobserved fact that potassium carbonate, which is quite insoluble in cold alcohol, is soluble in alcohol at 100°. The bicarbonate formed by absorption of carbonic acid from the atmosphere by an alcoholic solution of an alkaline hydrate becomes monocarbonate on heating, but this, being insoluble in cold alcohol, is unable to form a coloured compound with the phenol-phthalein until the liquid in which it exists being heated it dissolves, and affords another most striking illustration of the axiom "Corpora non agunt nisi soluta."

We have verified these conclusions by direct experiment with potassium carbonate and bicarbonate.

We desire also to note that the insolubility of potassium carbonate in cold, and its solubility in hot, alcohol, may be equally demonstrated if the colouring-matter employed be turmeric instead of phenol-phthalein; a solution of curcumine in absolute alcohol, in which a trace of pure and dry potassium carbonate is present, remaining in a sealed tube without change of tint, to become at once deeply reddened on heating to 100°.

* *Handworterbuch*, Band iii., S. 1058.
† Vol. iii., p. 25.

ON A FUNDAMENTAL LAW OF THERMO-CHEMISTRY.*

By CLARENCE A. SEYLER.

ONE of the most striking features of modern chemico-physical results is the demonstration of properties in a compound which are the sum of those of their components. This indeed is a necessity for the atomic theory, which supposes that bodies react in terms of units whose integrity remains inviolate throughout all changes. Up till recently, however, it was thought that mass was the only property of which this is true. Modern researches, however, have revealed it not only in the case of molecular heats, but in the refraction equivalents, and most strikingly in molecular volumes. Kopp showed that the molecular volume of a liquid at its boiling-point is the sum of two parts solely dependent on the nature of each component, and constant for each element in similar compounds. The law, however, is only observable when the bodies are compared in similar physical states, and hence it could not be well applied to solids until Nicol made the important step of comparing them in dilute solution. He then found that there exist constant differences of volume in solution between the salts of two metals with different radicals.† Thus—

$(K-Na)Cl = 10{\cdot}0$ to $10{\cdot}48$
$(K-Na)NO_3 = 10{\cdot}39$ to $10{\cdot}44$
$(K-Na)OH = 10{\cdot}06$ &c.

The same thing is true of salts of a pair of radicals with different metals. Favre and Valsen have also noticed the existence of these constant differences under the name of density moduli. The conclusion Nicol drew from these facts is that in solution the volumes of the compounds are the sum of two parts peculiar to the components and constant for each radical in whatever compound.

Now similar constant differences have been known since the time of Andrews, Favre, and Silbermann as thermic moduli of substitution.

Attention was again drawn to these by Tommasi in 1882. It was found that there exist constant differences between the heats of formation in solution of various metals with the same pair of radicals. Thus—

$H[Cl-Br]Aq = 10{\cdot}945$		$H[Cl-I]Aq = 26{\cdot}145$	
K ,, ,,	$= 10{\cdot}940$	K ,, ,,	$= 26{\cdot}150$
Na ,, ,,	$= 10{\cdot}930$	Na ,, ,,	$= 26{\cdot}150$
$\frac{Ca}{2}$,, ,,	$= 10{\cdot}940$	$\frac{Ca}{2}$,, ,,	$= 26{\cdot}150$
$\frac{Sr}{2}$,, ,,	$= 10{\cdot}940$	$\frac{Sr}{2}$,, ,,	$= 26{\cdot}150$
$\frac{Cu}{2}$,, ,,	$= 10{\cdot}940$	$\frac{Cu}{2}$,, ,,	$= 26{\cdot}150$

Favre and Silbermann, and Tommasi, applied these facts to the prediction of heats of formation then unknown experimentally, but the law has not yet advanced beyond this empirical stage.

A similar constancy of difference is observable if we compare the salts of different radicals with the same pair of metals. Thus—

$I\ [K-Na]Aq = 4{\cdot}660$	$I\ \left[\frac{Sr-Ca}{2}\right]Aq$	$= 4{\cdot}020$
$Cl[K-Na]Aq = 4{\cdot}650$	Cl ,,	$= 4{\cdot}020$
$Br[K-Na]Aq = 4{\cdot}620$	Br ,,	$= 4{\cdot}020$

The above data are taken from Muir's "Thermal Chemistry," but the only conclusion he draws from them is that they are fitted to throw light on the differences between the affinities of the bodies concerned ("Principles of Chemistry," p. 450).

* Read before the University College, London, Chemical and Physical Society, March 3rd, 1887.
† CHEMICAL NEWS, vol. xlix., No. 1261.

Lothar Meyer, in an article on the Foundations of Thermo-Chemistry (see CHEMICAL NEWS, vol. xlvii., p. 265), shows that with regard to heat of neutralisation it "consists always of two parts, the one depending only on the nature of the acid and the other on that of the base." This he draws as a conclusion from the law of Andrews, that the difference between the heat of neutralisation of two acids is constant whatever the nature of the base. I wish to show that this statement is true not only of heats of neutralisation of acids and bases, but is widely applicable to all cases of combination in solution; and thus we may obtain a generalised form of the law of moduli of substitution. From the existence of these constant differences we may evidently draw a provisional conclusion similar to Nicol's,—to wit, that the heat of combination of a compound is the sum of parts peculiar to the components and constant for each atom or radical. If this be true we may speak of the *heat of combination* of an element without further qualification, since this is independent of the body with which it is combined. Each atom should have a constant *thermal equivalent* just as it has a constant refraction equivalent, or a constant atomic volume, when compared under similar conditions. The object of the present paper is to draw the attention of chemists to the existence of this general and fundamental law of Thermo-Chemistry, to calculate, as far as possible, the thermal equivalents of each element, and to apply the law to the elucidation of the phenomena of neutralisation.

The term calorific equivalent was originally applied by Favre and Silbermann to the heat disengaged by the action of equivalent quantities of halogens upon each metal, and varied according to the nature of the halogen. I propose to apply the term thermal equivalent to the constant heats of combination which I shall show to be calculable for each element.

The data above quoted will not enable us to calculate the actual thermal equivalents of the elements, because there are always more unknowns than equations. The following reactions, however, will suffice:—

$[H,Cl]Aq = 39{\cdot}315$ $\quad [H,Cl,Am]Aq = 53{\cdot}691$
$[4Am,3Cl] = 124{\cdot}661.$

Now assuming the truth of the law that the radicals liberate or absorb the same amount of heat in all cases, we may write $H + Cl = 39{\cdot}315$, $H + Cl + Am = 53{\cdot}691$, $3Cl + 4Am = 124{\cdot}661$, whence we get $H = 16{\cdot}963$, and $Cl = 22{\cdot}352$.

Again, knowing $Aq[H,Br] = 28{\cdot}370$, we may by hypothesis put $H + Br = 28{\cdot}370$, whence Br is 11·407.

In a similar way we get $I = -3{\cdot}793$.

Again, from the heats of formation of the chlorides of various metals, we may easily obtain their thermal equivalents. Thus the heat of formation of calcic chloride being 187·600, we may put $Ca + 2Cl = 187{\cdot}600$, whence we find the thermal equivalent of $Ca = 142{\cdot}896$. In this way I have calculated the thermal equivalents of Li, Na, K, Ca, Sr, Ba, Mg, Cd, Zn, Al, Ni, Co, and Cu".

Now if the above law is true we ought to be able to calculate the heat of formation of the bromides or iodides of any of these metals by simply adding their thermal equivalents. The following are a few of the experimental and calcalated results:—

	Calculated.		Experiment.
K+Br	= 90·225	Aq[K,Br]	= 90·230
Na+Br	= 85·565	Aq[Na,Br]	= 85·580
Ca+2Br	= 165·700	$Aq[Ca,Br_2]$	= 165·800

The thermal equivalents of the metals are given in a Table at the end, and will be found to give results with close approximation.

Ferrous iron from the chloride is 55·246, and this gives correct results with the iodide and bromide. The thermal equivalent of ferric iron is, however, quite different, being 60·669. So with thallous thallium, Tl' = 16·128, while thallic Tl''' = 22·229; and stannous tin, Sn'' = 36·436, while stannic Sn'''' = 67·762.

The valency of a metal, therefore, has an influence on its thermal equivalent, an increase of valency being in each case associated with an increase of heat of combination. It is not therefore strictly correct to say that the heat of combination of an element is quite independent of the way in which it is combined. It is, however, constant in similar classes of compound. The same qualification is necessary in speaking of refraction equivalents or atomic volume. Hence we may speak of the thermal equivalent of ferrous or ferric iron, since it is constant in each class. So in the case of tin, &c., we must mention whether the tin be stannous or stannic.

Oxygen has a thermal equivalent which is constant in the hydrates. Thus $Aq[K,O,H] = 116{\cdot}460$, whence—

$$O = [K,O,H] - (K+H) = 20{\cdot}679.$$

Dealing thus with the hydrates of sodium, lithium, thallium, barium, strontium, and calcium, I find that in all these oxygen has a value approximately constant, and of mean worth 20·645. The following table gives a few of the calculated results to show the nature of the approximation:—

	Calculated.	Experiment.	Error.
NaOH ..	111·766	111·810	
LiOH ..	117·406	117·440	
TlOH ..	53·746	53·760	
BaO_2H_2 ..	226·812	227·120	0·13 per cent.

In the oxides of the above metals oxygen has a value constant, but different from that in the hydrates, and of mean value 6·830. This yields results such as the following:—

Na_2O	155·140	155·260
Li_2O	166·350	166·520
SrO	157·610	157·780

Sulphur in the sulphydrates and sulphides has a thermal equivalent constant for each class, but differing like those of oxygen, both, however, being large negative quantities:—

S in sulph-hydrates	−30·520
S in sulphides	−44·444

It is curious that sulphur and oxygen should have different values in the two classes of compound, since in both they are apparently similarly united.

In the sulphates, sulphur has also a constant thermal equivalent. In calculating this value we are met with the difficulty as to whether the hydroxylic oxygen has the same value as the unsaturated oxygen. I have used the value 20·645 for saturated oxygen, as in K−O−H, and 6·830 for unsaturated oxygen, as in Ca=O, perhaps somewhat unwarrantably. However, this does not affect the constancy of the number, which comes out as 125·536. Using this value we may calculate the heat of formation of any sulphate, thus:—

	Calculated.	Experiment.	Error.
Na_2SO_4 ..	328·802	329·050	0·07 per cent.
Li_2SO_4 ..	340·280	340·220	
Tl_2SO_4 ..	212·842	212·700	0·06 ,,
$CaSO_4$ ..	323·382	322·810	0·11 ,,
$MgSO_4$ ..	322·682	322·590	
$ZnSO_4$ ..	248·582	248·500	

So also with the sulphates of Ba, Cd, Co, Ni, Fe", and Cu".

The acid itself, however, H_2SO_4, calculated on this basis does not agree. $Aq[H_2,S,O_4] = 210{\cdot}770$, while $H_2 + S + O_4 = 214{\cdot}412$, thus showing a difference of 3·642. The same is true with water, $[H_2,O]Aq = 68{\cdot}360$, while $2H + O = 54{\cdot}571$. It thus seems that water differs from all other hydrates, and hydric sulphate from all other sulphates, in this respect. Thus the elements of water absorb 13·789 calories less on decomposition from metallic hydrates than they evolve on re-combining to form water.

Again, sulphuric acid absorbs 3·642 calories less on decomposition than its elements evolve on re-composition to form metallic sulphates. Whatever may be the cause of this curious difference it has, as we shall see, a most vital bearing on the very existence of the phenomenon of heat of neutralisation.

When we calculate the thermal equivalent of nitrogen in the metallic nitrates, we find that it has two values in two different classes of nitrates. The nitrates of the dyad metals are sharply marked off from those of the typical monad metals. Using values for saturated and unsaturated oxygen as in the sulphates, we find that in the nitrates of the monad metals, potassium, sodium, and thallium, nitrogen has a constant value $= -12{\cdot}210$, while in those of the dyad metals, Ca, Sr, Mg, Cd, Zn, Ni, Co, Cu″, it has a value approximately constant but only $= -2{\cdot}196$.

The cases of lithium and silver nitrate are peculiar: they both appear to belong to the second class rather than to the first, for the thermal equivalent of their nitrogen agrees with that in the dyad and not in the monad nitrates. Hence they would appear to be $Li_2N_2O_6$ and $Ag_2N_2O_6$, their formula being double that usually accepted. Calculated on this theory the heat of formation of lithium nitrate comes out 224·014, observed 223·830, error 0·08 per cent. The value for lithium used here gives correct results with the bromide (calculated 91·305, experiment 91·315), and with the iodide (calculated 76·105, experiment 76·100).

The thermal equivalent of silver cannot be got from the chloride or iodide, since these are insoluble in water. But calculated from the sulphate we get $Ag = -8{\cdot}843$. This gives for the heat of formation of silver nitrate, on the hypothesis that it is $Ag_2N_2O_6$, the number 46·532, observed 46·600. Hence we may infer that the molecular weight of silver nitrate is double the usually accepted number. That this is the case is not improbable from the position of silver in the periodic system, following a transition series, and being usually a pseudo-monad. Confirmation amounting to proof of this has been recently furnished by Ditte's preparation of the salts $AgKN_2O_6$, $AgRbN_2O_6$, $AgAmN_2O_6$ (*Ann. Chim. Phys.* (6), viii., 418), in which one of the silver atoms ot $Ag_2N_2O_6$ is replaced by an alkali metal.

Again, lithium being one of the so-called "typical elements," it is not surprising that it should differ from the other alkali metals. The following exhibits a few results of calculation on the nitrates:—

	Calculated.	Experiment.	Error.
$NaNO_3$ ..	96·252	96·220	
$TlNO_3$ ..	38·223	38·210	
SrN_2O_6 ..	215·214	215·200	
MgN_2O_6 ..	206·414	206·300	
ZnN_2O_6 ..	132·314	132·330	
CdN_2O_6 ..	115·810	116·120	0·2 per cent.

The data for the dithionates are also to hand. I find that in these sulphur has a constant value approximating to 88·352.

The results agree well with K, Na, Sr, Ca, Cu, Mg, and also with hydrogen, but not with nickel and silver, in which the value appears to be between 84·000 and 83·000. In the halogen salts of ammonium, nitrogen has a constant thermal equivalent, −18·294. In the alkaline carbonates, carbon is about 95·604, differing from that in CO_2. In chloric acid the thermal equivalent of Cl is −27·315, the same as that in potassic chlorate; and in the alkaline bromates and iodates the values of bromine and iodine are constant, and respectively $Br = -38{\cdot}835$ and $I = +4{\cdot}559$. These figures may be accepted as evidence that the halogens have not the same valency in the chlorates, &c., as in the chlorides, bromides, and iodides. This may serve to put the last straw on the back of those absurd linked oxygen formulæ which may still be seen hobbling along the pages of text-books.

It is only fair to mention here the few apparently anomalous results. The thermal equivalent of manganese is doubtful, from the nitrate 83·322. from the sulphate 83·286, from the iodide 82·586, while from the chloride only 73·296. Again, Au‴ from the chloride −39·786, but from the bromide, 29·231. Lead from the chloride 31·266, from the bromide 31·696, but from the nitrate 33·672, and the dithionate 32·896.

Let us now turn to the phenomena of neutralisation in the light of this law. The reaction—

$$KOH + HCl = KCl + H_2O$$

thermally expanded is—

$$Aq[KOH,HCl] = Aq[K,Cl] + Aq[H_2,O] - Aq[K,O,H] - Aq[H,Cl]$$

The reaction consists of a re-distribution, during which each atom undergoes a decomposition and a re-composition. If, according to the above law each atom evolved, on combination, as much heat as it absorbed on decomposition, the effect of each would be nil, and the neutralisation of an acid by a base would be attended by no thermal change. But here comes the importance of the fact before noted, that the elements of water evolve 68·360 calories on re-composition, as against only 54·371 absorbed on decomposition. Hence, while the total effect of all other atoms is nil, that of the elements of water in their re-distribution is an evolution of 13·789 calories. From this we draw the following inferences.

(1) The very existence of the phenomenon of heat of neutralisation of a basic hydrate by an acid is due to the abnormal behaviour of water. Did the elements, in uniting to form water, evolve the same amount of heat as in all other hydrates, there would be no such thing as heat of neutralisation.

(2) Other things being equal, the heat of neutralisation should depend solely on the amount of water liberated in the reaction. Hence, since monobasic acids liberate one molecule of water, and dibasic acids two, it follows:—

(3) That all monobasic acids should, *ceteris paribus*, have the same heat of neutralisation, equal to the difference between the theoretical and actual heat of formation of water, *i.e.*, to 68·360−54·571 or 13·789.

(4) That dibasic acids should have a constant heat of neutralisation, equal to twice that of monobasic acids, or 27·578 cals.

These conclusions are well known to be true for hydrochloric, hydriodic, hydrobromic, and nitric acids, with all basic hydrates, also for bromic, iodic, and chloric acids, in which, as I have shown, the halogen has the same thermal equivalent as in the metallic salts. Their heat of neutralisation is about 13·780.

It is true of the dibasic acids, dithionic, selenious, chloroplatinic, and fluosilicic acids, whose neutralisation heat is about 27·000 cals.

In the case of sulphuric acid, as we saw, before the decomposition of its elements absorbs only 210·770 cals., while their re-composition evolves 214·412, or rather more, since its hydrogen goes to form water. Hence, when sulphuric acid neutralises a basic hydrate, in addition to the 27·578 cals. due to the water liberated, there are 3·642 cals. due to the re-distribution of the elements of the acid. This would make the heat of neutralisation of sulphuric acid 31·220, the average number by experiment being about 31·347.

In the same way the reaction—

$$Na_2O_2H_2 + CO_2 = Na_2CO_3 + H_2O$$

frees one mol. of water, equivalent to 13·720 cals. But the decomposition of CO_2 absorbs −102·840 cals., while the re-composition of these elements in sodic carbonate evolves 109·329. Hence we have an additional 6·489 cals. to add to the 13·720, which makes the heat of neutralisation 20·209; obverved, 20·180. So with—

$$SH_2 + NaOH = NaSH + H_2O$$

we have the decomposition of SH_2 absorbing −9·300, while the re-composition evolves only 3·295, the total

effect being −6·005. This we have to subtract from the 13·720 liberated by the water, giving 7·715 for the heat of neutralisation; observed, 7·740.

Hence it appears that the law to which attention has been directed in this paper is a generalisation of both the empirical laws of Andrews and of the moduli of substitution. Both these laws are included under it, and it may be stated thus:—*In similar compounds an atom evolves or absorbs on combination in solution an amount of heat which is constant whatever the nature of the body with which it combines,** or every atom has a constant thermal equivalent *under similar conditions.*

If the thermal equivalents of the atoms A, B, and C be respectively α, β, and γ in a given class of compounds, then the heat of formation in solution, H, of any compound $A_x B_y C_z$—

$$H = x\alpha + y\beta + z\gamma.$$

Hence with a table of thermal equivalents we easily calculate the heat of formation of any required compound. The old law of moduli enabled us to do this, but being an empirical and approximate law, Berthelot, if I remember rightly, condemned it as belonging to a past period of chemical science. But when rightly understood it forms the basis of the law of constant thermal equivalents as above enunciated, and this taken in conjunction with the constant refractive equivalents, atomic volumes, and heats, and Ostwald's work on affinity, seems to me to be of the utmost theoretical importance. Every heat change during a chemical reaction probably consists of a primary part *obeying the above law*, and of secondary physical changes from which, except in solution, we cannot separate it.

What is now needed for the further generalisation of the huge masses of thermo-chemical data, is a study of the attendant physical changes. Accordingly it is to experiments on the relation of the heat change to the change in the amount of disgregation during such physical processes as fusion, evaporation, and solution that we must look for help. An attempt to find the relation between the heat of fusion and amount of disgregation was made by myself some years ago (CHEMICAL NEWS, vol. xlix., 1260) which, though I cannot regard it as very successful, is still, I believe, a step in the right direction.

There is evidently plenty of room for experimental research in this direction, and also on the heat of solution of organic bodies in liquids other than water. In this way we should find the heat of formation of organic bodies in solution, and thus apply the law to them also.

In conclusion I may mention that the thermal equivalent, like the atomic volume, &c., appears to be a periodic function of the atomic weight.

Table of Thermal Equivalents.

H = 16·963							
Li	79·898	Cl′	22·352	Cu″	18·006	Al‴	170·769
Na	74·158	Br′	11·407	Ag′	−8·825?		
K	78·818	I′	−3·793	Au	?	Tl‴	22·229
Zn	68·096	Fe″	55·246	Mg	142·196		
Cd	51·596	Co	50·116	Ca	142·896		
Hg	15·156	Ni	48·996	Sr	150·996		
Fe‴	60·669	Mn	83·300?	Ba	151·596		
C	95·600	Sn″	36·436	Tl′	16·128		
Sniv	67·762	O in hydr.	20·645	S in MSH	−30·520		
Pb	33·672?	O in oxides	6·830	S in M_2S	−44·444		
S in sulphates	125·536			In dithionates	88·352		
N in ammonium salts	−18·294						
N in MNO_3	−12·210			In $M''N_2O_6$	−2·196		
C in carbonates	95·600						
Clv in chlorates	−27·315						
Brv	−38·835			Iv	+4·559		

* This statement is perhaps objectionable, as appearing to attribute the heat evolved to each atom separately instead of to a joint action and reaction. To avoid such an implication it would be better simply to state that the *heat of combination of a compound is separable into parts constant for each element (under similar conditions), and these constants are called the thermal equivalents of the atoms in a given class of compound.* This is a statement merely of fact, and independent of any theory.

In offering the above Table I do not regard the numbers as final, but many, especially those for the variable non-metals, may have to be modified as we understand the law better. In using them I do not think we make any theoretical assertion other than that implied in the use of the similar refraction equivalents and the so-called "atomic volumes." They at present simply indicate that the heat of combination due to the action and reaction of atoms is separable into parts constant under certain conditions for each element, and these parts are the above thermal equivalents.

It is difficult to form a true scientific concept of such a separation, but this only adds to the importance of such a possibility, and this paper, it is hoped, will draw the attention of chemists to a fact which ought not to be overlooked in attempting to ascertain the true nature of the changes in heat-energy which accompany chemical action.

NOTE ON THE DETERMINATION OF THE TOTAL NITROGEN IN ORGANIC MATTERS.

By M. RAULIN.

THE Dumas procedure is certainly the most accurate method of determining nitrogen in organic substances, and it has the advantage of being applicable for nitrogen in all its states. But in its original form it is neither sufficiently expeditious nor practical for the daily operations of an analytical laboratory.

The author has sought to render it as simple and as rapid as the most practical methods, without sacrificing anything of its accuracy and its generality. The apparatus is composed of the following portions.

1. An apparatus for generating carbonic acid, on Deville's continuous system, from marble and pure hydrochloric acid, followed by two washing-bottles, one with marble and the other with sulphuric acid. The two recipients for marble and acid should have at least a capacity of 3 litres, and the delivery tube issuing from the marble-bottle must be connected by a caoutchouc tube to another tube reaching to the bottom of the acid-bottle so as to liberate there slowly carbonic acid, which expels nitrogen and oxygen; a Mohr's pinch-cock regulates this current, and a bulb tube prevents the external air from entering into the acid bottle whilst allowing the carbonic acid to escape freely.

2. This apparatus transmits a current of carbonic acid (regulated by means of two Mohr's pinch-cocks) through the combustion-tube. This is a tube of copper, 1·80 metre in length, 18 m.m. in diameter, and 3 m.m. in thickness. It is surrounded with four brass jackets, between which and the combustion-tube there is an interval of 5 m.m. Each of these jackets is 10 c.m. in length, and is fitted with two tubulures, by which the jackets communicate one with another through caoutchouc tubes. The first jacket communicates with a water-tap, and the last is fitted with a caoutchouc tube for the escape of the water. Two of these jackets are at the ends of the central tube, whilst the two others are placed equidistant in the intervening space. During the operation all four are traversed by a current of cold water to cool the central tube.

3. This central tube communicates at its free extremity by means of an escape tube with a small trough of potassa half saturated; this trough is about 40 c.m. in height. The solution of potassa is covered with a thin layer of petroleum in order to diminish carbonisation by the air. Upon this vat, held by the jaws of a support, there are two tubes graduated to 100 c.c. Into the potash plunges a pipette with two branches, the one capable of connection with each graduated tube, and the other fitted with a bulb.

4. A small furnace, of 25 c.m. in length, serves to heat in succession each of the intervals of the central tube

between the jackets. It can be withdrawn without disturbing the combustion-tube. For this purpose it is merely necessary to remove the tiles on one side and to let down two hooks at the end.

To use the apparatus we introduce into the tube a spiral cylinder of copper wire gauze, of a diameter equal to the internal diameter of the tube, and of the length of 6 c.m., so that its anterior extremity may be 10 c.m. from the anterior jacket; then, by means of a long and perfectly dry glass tube-funnel we introduce 60 grms. of oxide of copper in small grains; then we introduce the mixture of the organic matter and oxide of copper; the weight of the organic matter must be such as to yield from 60 to 80 c.c. of nitrogen. It is mixed at first with a little oxide of copper in powder and 20 grms. of oxide in grains to 8 decigrms. of the material. The funnel is then rinsed out with a little oxide in grains.

In the same manner we introduce a sample of another organic matter in the second interval of the tube between the second and the third jacket, with a second cylinder of copper gauze and oxide of copper.

Lastly, a third sample is introduced into the third interval.

The tube is then put in its place, a current of carbonic acid is passed in to clear the tube, and when the residue of the gas, not absorbable by caustic alkali, which enters the first graduated tube does not exceed ½ c.c. in a quarter of an hour, we let the current of water pass through the jackets; the gas of the graduated jar is absorbed by the pipette and the combustion of the first sample is effected, working from the front backwards, and taking no precaution beyond decomposing completely all the material and not developing the gas too abundantly at once.

When the residual gas no longer appears to increase we stop, with the first Mohr's pinch-cock, the current of carbonic acid, wash the gas in the graduated jar with the alkali of the pipette and read off. The gas is then absorbed with the pipette and the development of gas is continued. We make ourselves then certain that the residue obtained in a quarter of an hour does not exceed ½ c.c. This residue is then measured by adding it to the previous volume; we note the duration of the operation, and read off the volume of the gas in the second graduated jar, after having washed it by means of the alkali of the pipette. We then pass on in the same manner to the combustion of the second sample after having absorbed the gaseous residue with the pipette. After completing the third sample carbonic acid gas is passed through for half an hour and the gaseous residue is measured.

To calculate the weight of nitrogen of one of these samples we deduct from the total volume of nitrogen obtained for this sample the volumes of oxygen and nitrogen liberated by the carbonic acid alone during the time of combustion.

Let V be the volume of gas thus corrected, let v be the volume of permanent gas of the second graduated jar, and p the weight of nitrogen of the same volume under the same conditions. The weight of nitrogen sought for will then be—

$$p \cdot \frac{V}{v}$$

It is sufficient to calculate p once for all. For this purpose, before the experiment, the second graduated jar is washed with water, stoppered loosely with a stopper fitted with a thermometer, and left to itself for some time near the alkali trough; the temperature, t, is read off, the graduated jar is placed suitably over the potash, the volume, v', of the gas, the barometric pressure, H, is read off, and the equivalent height, h, of the mercury. Lastly, the maximum tension, F, of watery vapour at the temperature t is found.

We have then—

$$p = 1{\cdot}3 \text{ m.gr.} \times 0{\cdot}972 \times v : \frac{1}{1+at} \times \frac{H-h-F}{760}$$

—*Bulletin de la Soc. Chimique de Paris* (xlvii., No. 2, p. 94).

A CONVENIENT SUBSTITUTE FOR SEALED TUBES FOR HEATING UNDER PRESSURE.

By ARNOLD EILOART, B.Sc.

This device arose from a special difficulty in the heating of ether under pressure. 150 c.c. of ether, with an equal volume of an aqueous solution, were heated to 100° in a soda-water bottle, closed with a dense cork wired down. On cooling, the cork was found unmoved, but nothing was to be seen in the bottle, though it was mouth downwards under water. The ether had so attacked the cork, though the aqueous solution was between, that crystals of salt from the solution were found in the body of the cork, which had also shrunk, but not enough to admit water on cooling, so that the bottle finally contained ether vapour and air only.

A soda-water bottle with ball-stopper was tried, with mercury to prevent the ether attacking the caoutchouc ring against which the ball presses to close the bottle. The difficulty was to close the bottle so filled, seeing that ordinarily, when the bottle closed by the thumb is inverted, the glass ball floats on the mercury: the bottle closed by the thumb was gradually inclined till the ball just rolled into its place, when the bottle was promptly inverted and the thumb at the same time removed. In this way, after a few trials, closure may be effected every time with the escape of only a few drops of liquid and not a drop of mercury. The bottle, still inverted, and having an inch or two of mercury in the neck, was boiled, and found in repeated experiments to stand the pressure of the ether perfectly. Moreover, the necessity of corking and wiring is avoided.

To prevent negative pressure, and consequent displacement of the ball, the bottle should be kept warm until it is to be opened.

King's College Laboratory,
March, 1887.

ON THE VARIATIONS OF THE ABSORPTION SPECTRA OF DIDYMIUM.

By HENRI BECQUEREL.

In a communication recently made to the Academy (*Comptes Rendus*, civ., 165) the author has shown that among the absorption-bands of the crystalline compounds of didymium, a certain number present, in their principal directions of absorption, differences which seem to reveal the existence of as many distinct substances.

Observations of another order lead to the same conclusions. If we compare with each other the absorption-spectra of different crystals, natural or artificial, containing didymium in the state of different combinations (parisite, monazite, apatite, scheelite, strontianite from Scotland, leucophane, didymium sulphate, double didymium or lanthanum nitrates with potassium, ammonium, zinc, &c.), we find that there exist in these spectra a great number of bands whose aspect is characteristic. But their different relative distances or the wave-lengths of the radiations observed vary from one body to another. On comparing the spectra of these crystals two by two we see, for instance, an entire series of bands displaced in one direction, whilst another series remains fixed; these series vary from one body to another, so that almost all the bands are individually displaced by quantities variable in one direction or in the other.

Occasionally certain bands are wanting, the substances which produce them having been eliminated either in natural crystals, or in the chemical operations by which the matters studied have been obtained.

Variations of the same kind are observed on dissolving water one of the artificial crystals mentioned above. In this case we may, before dissolving the crystal, identify all the absorption-bands and seek to find them again in the solution. As in this we observe the superposition of the principal different absorption-spectra of the crystal, the bands which in the crystal disappear, for certain directions of the luminous vibrations will be more or less weakened in the spectrum of the solution; further, certain bands lose their definiteness in consequence of the juxtaposition of several neighbouring bands belonging to different principal spectra. Excepting these modifications, which are generally easy to recognise, we find in the solution the chief bands observed in the crystal; but among these bands some remain fixed whilst others are unequally displaced in one or the other direction.

In a table the author gives the approximate wave-lengths of some of the absorption bands which present the most distinct variations between the spectra of the crystals and those of their concentrated aqueous solutions. In this table there are found neither the bands of the red region nor the numerous bands of the characteristic group near D between the wave-lengths 598 and 574, for which the multiplicity of the neighbouring bands does not permit us to follow distinctly the displacement of each.

In the table the author gives the comparative wave-lengths and the displacements for the crystals and the solutions of didymium sulphate, didymium and potassium nitrate, and lanthanum and potassium nitrate. The bands from 571·7 to 511·5 are referred to neodymium; those from 482·3 to 446·5 to praseodymium; and that of 428·5 to neodymium.

It is noted that whilst some of the bands are unaffected others are displaced considerably in one direction or in the other.

Similar variations are not observed with well-determined bodies; thus, with the various compounds of uranium, every modification which, from a chemical combination or the solution of the crystals affects one of the bands, affects at the same time all the others in the same manner. It is the same if we dissolve certain colouring-matters in the various solvents: all the bands are displaced at once in the same direction.

The phenomena presented by didymium may be explained if we admit that each of the variable bands belongs to a distinct substance. If in these various combinations each of these substances behaves differently, if each in the state of sulphate or nitrate becomes more or less hydrated according as it is in presence of one salt or of another, we see that the corresponding bands must undergo individual modifications analogous to those observed. It is necessary to add that precisely differences of this order in their chemical properties have enabled several groups of these bodies to be separated.

The observation of the unequal displacements of the bands under the conditions indicated above furnishes us, therefore, with a method for characterising substances chemically different.

We find thus that most of the bands given in the table may be ascribed to different substances, in particular the three bands of praseodymium, 481·9, 469·0, 445·0, the group 475·5; then the bands of neodymium, 571, 523·9, 521·4, 520·5, 511·5, 427, without including other bands in the red region and in the group near D; these wave-lengths refer to the solution of the nitrate. It is remarkable that the spectra of the solutions of the various double nitrates are all identical, although the spectra of the crystals of these double nitrates present very striking differences; it seems that the double compound is destroyed in dissolving. The bands just enumerated are precisely those which in the crystals have particular principal directions of absorption, and of which several groups have been separated chemically.

These bands present, therefore, at once a crystalline individuality and a chemical individuality. Still we cannot yet decide if the matters producing them are really all distinct simple bodies. It is not doubtful that the absorption-bands mentioned are due to matters presenting a certain number of the properties which characterise simple bodies, but it may also be that a certain number of these matters are combinations of one and the same substance either with some other substance or with itself, and that these combinations are so stable that hitherto one has not been transformed into another. In this case the variations of the absorbent properties would be quite analogous to those which the author has observed in the uranous and uranic compounds.

Lastly it must be noted that the wave-lengths of the characteristic bands of these different substances present, among themselves, certain relations which seem to attach them to a common origin. To this question the author proposes shortly to return.—*Comptes Rendus*, civ., p. 777.

THE POST-MORTEM DETECTION OF CHLOROFORM.*

By CHARLES LUDEKING, Ph.D.

In an important trial for murder recently held in St. Louis, the author of this paper made a chemical examination of the viscera of the victim, at the request of the coroner, and obtained very decided reactions for chloroform, notwithstanding the fact that the examination was not undertaken until about twelve days after death. The lungs, usually congested in case of death by chloroform, were selected as best suited for its detection. The great volatility of chloroform would seem *a priori* to preclude the possibility of its detection so long after death, and as at the time there was considerable doubt expressed as to the reliability and accuracy of the experiments, the author determined, once for all, to decide the matter by direct experiment, and so set to rest all doubts.

The literature was first scanned carefully to ascertain whether there were any prior experiments in this direction, but nothing could be found. My direct object was then to determine how long after death chloroform can, with certainty, be detected; as also whether or no any substances are generated by the process of decomposition, which might give similar reactions to chloroform, and thus lead to erroneous conclusions.

The manner of experimenting was simple and direct. Dogs of from 15 to 20 pounds weight were destroyed gradually by the administration of chloroform through the lungs in from 5 to 10 minutes. Then the carcases were allowed to stand in summer's heat or the temperature of the room for different periods of time, and finally the lungs removed and tested for chloroform, by the Ragsky method.† In the following the experiments are briefly given.

Experiment I.

Carcass exposed on a dissecting table, during full summer's heat, for six days and ten hours. Decomposition far advanced and an exceedingly offensive odour given off. The lungs were removed, and after having been finely minced and rendered *slightly* alkaline by means of sodium carbonate, were heated over a water-bath in a flask through which a current of air was slowly passing. The escaping gases were sent through a Bohemian glass tube, which was heated to bright redness over a space of 2 inches. The iodised starch paper was 5 inches distant from this heated portion of the tube, and throughout the experiment remained perfectly cool.

A very strong blueing of the paper was observed, and the nitrate of silver solution was strongly precipitated.

Experiment II.

Carcass exposed during full summer's heat for ten days. It had then lost all solidity, the hair literally falling off by

* Presented before the St. Louis Academy of Science, June, 1886.
† *Erdmann's Journ.*, xlvi., 170.

the slightest abrasion. The lungs were removed and examined as in Experiment I. A very decided reaction for chloroform was obtained.

Experiment III.

Carcass exposed during full summer's heat for ourteen days. The lungs then removed and examined as in Experiment I. The reaction for chloroform was very decided.

Experiment IV.

Carcass placed in an ice-chest for three weeks, and then exposed for ten days during full summer's heat. The lungs were then examined as in Experiment I., and a strong reaction for chloroform obtained.

I do not hesitate to say that in winter chloroform could be detected without the slightest difficulty for many months after death.

Experiment V.

Carcass exposed in a room (70° F., very constant) for three weeks and three days. The lungs were then examined as in Experiment I., and a very decided reaction for chloroform obtained.

Experiment VI.

Carcass exposed in a room (70° F., very constant) for four weeks. The lungs examined as in Experiment I., and a decided reaction for chloroform obtained.

The question now arises whether there cannot be substances formed by the process of decomposition, which, resembling chloroform in certain chemical reactions, might therefore lead to erroneous conclusions. Dr. Ragsky already partially answered this question experimentally. The author made three experiments to this end which are herewith briefly given.

Experiment I.

The lungs of a slaughtered bull exposed during full summer's heat for ten days. Not a trace of reaction of chloroform could be obtained by the Ragsky method.

Experiment II.

The lungs of a slaughtered bull exposed during full summer's heat for fourteen days. Not a trace of reaction of chloroform could be obtained by the Ragsky method.

Experiment III.

Carcass of a dog destroyed by coal-gas was exposed in a room (70° F., very constant) for three weeks and four days. No chloroform reaction could be obtained by the Ragsky method.

Conclusions.

1. By the process of decomposition no substances are generated which could vitiate the tests for chlororform by the Ragsky method.

2. Chloroform, when it has caused death by inhalation, can with certainty be detected in the body four weeks after death, and, notwithstanding its volatility, it is certainly retained in the viscera in large amount during this time.

In the case which was the cause of these experiments being undertaken, the victim had been dead at least ten days before the body was discovered, in high state of decomposition. On the strength of the Ragsky and Hofmann tests the author gave it as his sworn opinion that the deceased had chloroform in his viscera, whereupon a charge of murder by chloroform was preferred. Maxwell, the culprit, finally, after the lapse of an entire year, made confession that chloroform had indeed been the cause of death.

It being certain, finally, that chloroform can be detected a long time after death, as evidenced by our experiments, we must next try to understand why this should be so. The following may serve to this end.

R. Dubois* finds that the vapour of chloroform penetrates into the interior of the tissues, and becomes substituted for normal water. This is not a phenomenon of desiccation or osmose; a true affinity comes into play, the protoplasm absorbing the vapour of the anæsthetic and expelling a certain quantity of water.

Chancel and Parmentier* have proven that chloroform has a very decided affinity for water.

The author allowed to stand open a flask containing water, holding a small quantity of chloroform in solution After two weeks' time the chloroform reactions could still be obtained without any difficulty.

Add to the above that chloroform is a powerful preservative agent† we have a collection of factors sufficient to enable us to understand the lengthy occlusions of chloroform in the animal body, though others of minor importance might be adduced besides these.

Grehaut and Quinquand,‡ experimenting on dogs, find the amount of chloroform necessary to produce anæsthesia to be at least one grm. to every two litres of blood. On the basis of these results, the total quantity of chloroform in the blood of a man of 150 pounds weight would be 2¾ grms. approximately, when rendered insensible through its inhalation. The amount necessary to produce death would, under normal conditions, certainly not be less than this. Under the assumption that one-sixth of the entire quantity of blood circulating in the body is at all times passing through the lungs, the quantity of chloroform in the lungs of a man of 150 pounds weight, rendered insensible from its inhalation, would be about one-half grm.

We desire to emphasise by this calculation that there is an abundanee of material in the lungs for the detection of chloroform. The liver would undoubtedly also be very suitable for its detection.—*American Chemical Journal*, Vol. viii.. No. 5.

* Chemical News, liii. 311

ON MERCUROUS HYDRATE.

By G. B. BIRD.

Since cupric hydrate is readily formed by precipitation, at common temperatures, with an alkaline hydrate, and is subsequently so easily decomposed by heat, it appeared probable that, while the oxides of silver and mercury are precipitated from their solutions by alkaline hydrates, the corresponding hydrates of these would be formed if operating at a lower temperature. Pursuing this suggestion, in this laboratory, in 1884, Mr. J. D. Bruce undertook the formation of argentic hydrate; and it appeared that in dilute alcohol argentic hydrate decomposes at all temperatures above −40° C.§ Employing a similar method, Mr. Bird has endeavoured to obtain mercurous hydrate.

A dilute solution of mercurous nitrate was mixed with alcohol, cooled to −18° C., and the small amount of salt which separated filtered off, thus obtaining 70 per cent alcohol saturated with mercurous nitrate. A similar solution of potassium hydrate was made, and in the following experiments these were used in such amounts as gave a slight excess of the potassium hydrate solution.

When mixed at common temperature these alcoholic solutions afforded the same brownish black precipitate of mercurous oxide that is obtained from aqueous solutions. Corresponding portions of these solutions were put into test-tubes, and these cooled to −37° C., and then united and mixed by stirring; a flocculent precipitate of red-amber colour was slowly formed, which subsided very slowly: as this was warmed it gradually darkened, until at −18° C. it was of a slate-grey colour, with a yellowish green portion suspended in the liquid.

Another experiment, beginning at a temperature of −39° C., afforded the same results.

* *Comptes Rendus*, c., 27.
† Robin and Augendre, *Comptes Rendus*, xxx., 52; xxxi. 679.
‡ *Comptes Rendus*, xcvii., 753.
§ Chemical News, vol. l., p. 208.

The most satisfactory experiment was made on a morning when the temperature of the atmosphere was −18° C.

The bottom of a test-tube was perforated, and the tube was then drawn out, forming a pipette, the bulb of which was at its lower end, and fitted into another test-tube, in which the potassium hydrate solution was put: by this arrangement the solution could be cooled in the pipette and transferred to the tube containing the mercurous nitrate with very little alteration of temperature. Using sufficient of one solution to correspond to one pipetteful o the other, these were cooled to −42° C. The perfectly clear though somewhat viscous liquids were then mixed. At first the solution showed only a pale yellow colour; after a minute a very pale amber flocculent precipitate formed slowly, and remained suspended in the liquid; after two hours the temperature had risen to −23° C., the main portion of the precipitate had subsided and was darkened a little, the suspended portion being yellowish green; after four hours the temperature was −18° C. and the precipitate of a dirty yellow colour; after six hours the temperature was −10° C., the colour was slightly darker and more greenish. A portion of this precipitate was collected, dissolved in cold nitric acid, and proved to contain much mercuric salt.

Judging from the colours of the corresponding compounds of lead, copper, silver, and mercury, it appears very probable that the pale amber-coloured precipitate obtained was mercurous hydrate, and that it readily decomposes by heat, forming in part mercurous oxide and water, and more largely mercuric oxide, mercury, and water.—*American Chemical Journal*, vol. viii., p. 426.

DETERMINATION OF NITROGEN IN COMMERCIAL FERTILISERS.*

By B. B. ROSS and L. W. WILKINSON.

At a meeting of official Agricultural Chemists held in Washington, September 1 and 2, 1885, the committee on nitrogen reported that the samples sent out by the committee were so few and meagre and the discrepancies so large as to make it inadvisable to recommend any method for the determination of nitrogen for use during the next season, and recommended that the entire report of the last committee be referred, without further action, to the next committee on nitrogen. The new committee, in accordance with the report referred to, sent out other samples during the present year with specific instructions to be followed in determinations according to the Ruffle method, the one proposed by the committee for adoption by the Association. Nitrogen was also determined in the same samples, for the purpose of comparison, by the soda-lime and the Kjeldahl methods. As these determinations were made with great care, the results are believed to be of sufficient interest to justify their publication.

The reagents used in the Ruffle method consisted of standard solutious of sulphuric acid and caustic potash, one-forth normal; soda lime crushed, one-half in form of powder and one-half granular; sodium hyposulphite, commercial, fused, water-free, and powdered; finely powdered charcoal and flowers of sulphur, equal parts by weight; and cochineal solution as an indicator. The combustion tube was twenty inches in length and one-half inch in diameter.

The samples used for analysis were represented to consist of Nos. 1 and 2, ordinary commercial fertilisers containing nitrogen, No. 3, a rather superior sample of cotton-seed meal, and N. 4, a nitrate mixed with sugar.

Careful analysis of the chemicals used in the Ruffle method showed them to contain a small percentage of nitrogen which is allowed for in the following results:—

Results according to the Ruffle Method.

	(*a*).	(*b*).	(*c*).	Average
No. 1—Nitrogen found ..	1·83½	1·86	1·85	1·8483
No. 2 „ „ ..	2·15	2·16½	2·15	2·1541
No. 3 „ „ ..	7·66½	7·57½	7·35	7·53
No. 4 „ „ ..	3·45	3·39½	3·35	3·3983

Results according to the Method with Soda Lime.

	(*a*),	(*b*).	(*c*).	Average
No. 1—Nitrogen found ..	1·84	1·85	—	1·845
No. 2 „ „ ..	2·05	2·12½	—	2·0875
No. 3 „ „ ..	7·25	7·27½	—	7·2625
No. 4 „ „ ..	2·10	2·12½	—	2·0875

Results according to the Kjeldahl Method.

	(*a*).	(*b*).	(*c*).	Average
No. 1—Nitrogen found ..	1·85	—	—	—
No. 2 „ „ ..	2·17½	—	—	—
No. 3 „ „ ..	7·33	—	—	—
No. 4 „ „ ..	—	—	—	—

From eight to ten hours' digestion with sulphuric acid was required in the Kjeldahl method and about three-quarters of an hour for distillation, making it long and tedious. No. 4, consisting of sodium nitrate and sugar, yielded totally unreliable results, and is omitted. The quantity of material sent was too small to allow of other determinations.

The above determinations show the uniform and satisfactory results obtained by the Ruffle method, and commend it to the favourable consideration of agricultural chemists especially.

NOTICES OF BOOKS.

The Economical Aspects of Agricultural Chemistry. An Address read before the American Association for the Advancement of Science. By Harvey W. Wiley. Cambridge: J. Wilson and Son. University Press. 1886.

"The prosperity and advancement of a nation depend chiefly on its agriculture. The first and most insistent demands of a human being are for food and clothing, and for these he depends exclusively on the products of the field." In these words Mr. Wiley calls our attention in a very forcible manner to the extreme importance of agricultural chemistry, a branch of science which has until comparatively modern years been too much neglected.

In the olden times, when populations were not so large as they are at present and competition was not so great, farmers were easily enabled to grow enough wheat, &c., for the wants of the district, and the prices were fairly remunerative; but now that the demand has increased to such an enormous extent, and the importation of foreign bread-stuffs has brought down the prices, no stone should be left unturned or precaution neglected to increase the yield per acre. It has been shown over and over again that it *does* pay to use chemical manures, but for all that they are not used to anything like the extent they should be. The percentage of potash removed from the soil and found in the ash of the grain of cereals varies from 16·33 per cent in the case of oats and barley to over 31 per cent in wheat and rye, and in the straw from 13·6 per cent in wheat to 46·8 per cent in buckwheat. The percentage of phosphoric acid varies from 23 per cent to 48·6 per cent in the grain, and from 4·5 per cent to 12·6 per cent in the straw of the same cereals.

If these figures are applied to the total quantity of grain raised every year in the United States, we find the enormous totals of 4,035,586,388 lbs. of potash and 2,714,585,473 lbs. of phosphoric acid which ought to be returned to the soil every year, to keep it up to the same standard of fertility: these figures represent 28·2 lbs. of

* "Notes of Practical Work in State Laboratory, Auburn, Alabama." Communicated by N. T. Lupton, Professor of Chemistry in the Agricultural and Mechanical College, and State Chemist.

potash and 19 lbs. of phosphoric acid per acre. The hay crop, again, removes a very large quantity of these necessary constituents, viz., 1,418,788,800 lbs. of potash and 468,795,600 lbs. of phosphoric acid.

Similar calculations are given for the other constituents of the soil, the total value of all being 3,343,786,050 dollars.

These quantities of plant-food removed rom the soil annually seem enormous, but it must be remembered that they are not all lost; much is left in the soil in roots, straw, stalks, &c.

The store of plant-food in virgin soil is of course very great, but it is quite impossible that it can withstand this constant drain for very long: that this is true is shown by the diminished yield in the great wheat-fields of California and the North-West, which do not now produce more than half the crop at first obtained from them.

In view of the fact that nitrogen is one of the most abundant of the elements, it may appear strange that so high a value is placed on it, or that there should be any question as to the abundance of the supply. There has been much discussion as to the form in which nitrogen enters into plant-life, and there is still much difference of opinion as to the possible sources. Mr. Wiley mentions organic nitrogenous matter, ammonia in the air, nitric and nitrous compounds formed by combustion, free nitrogen in the air, &c., and he goes on to consider the merits of these different views, and concludes that the combined nitrogen which is the product of vegetable and organic life forms the chief source of nitrogen for the growing plant.

Manure is not the only requisite to plant-life, a certain amount of warmth and light being quite as indispensable. "If it be true, therefore," says Mr. Wiley, "that the earth is gradually cooling, there may come a time when a cosmic athermancy may cause the famine which scientific agriculture will have prevented. Some time in the remote future the last man will reach the equator. There, with the mocking disc of the sun in the zenith, denying him warmth, flat-headed, and pinched as to every feature, he will gulp his last mite of albumenoids in his oatmeal, and close his struggle with an indurate inhospitality."

Notes on the Literature of Explosives. By Charles E. Munroe. Nos. X. and XI.

The first paper noted and commented upon is one by Dr. Jenssen on the "Causes of Explosions in the Manufacture of High Explosives." These are generally traced to improper construction and faulty arrangement of the works and machines, carelessness on the part of the workmen, and maliciousness. As an example of the latter the writer cites one, from his own experience, where a quantity of tips from phosphorus matches were placed in a bag of infusorial earth, and were not discovered until the earth had been made up into dynamite.

Several papers follow on the chemistry, the composition, and the physiological action of nitro-glycerol.

In some experiments made by Berthelot, to determine the rate of transmission of the explosive wave in solid and liquid explosives, he found that as a rule the rate of propagation of the explosive wave increases with the density of loading, and also with the diameter of the tube in which the experiments were carried out, the tubes used in these cases being 1 to 2 m.m. diameter and 100 to 200 metres long. The results were sensibly the same whether the tubes were bent or straight.

Among the processes used in producing metallic potassium is that in which an intimate mixture of potassium carbonate and charcoal is heated in an iron retort. The potassium is thus reduced, but there is unfortunately another secondary reaction, through which a black compound is formed which detonates violently upon the slightest friction.

The final Report of the English Royal Commission appointed to enquire into accidents in mines is here commented upon. Not much is recommended in the way of legislative changes, but the scientific recommendations are most interesting and important.

With reference to exploding shots in mines they say—"Electrical exploding appliances present very important advantages, from the point of view of safety, over any kind of fuse which has to be ignited by the application of flame to its exposed extremity. . . . The use of electrical arrangements for firing shots in mines, where the employment of powder for blasting is inadmissible, should be encouraged as much as possible."

While engaged in the manufacture of zinc, Col. S. Wetherill devised a plan for recovering the "blue powder," or finely divided zinc, deposited in the condenser. It consisted in pressing it into blocks and melting them down into spelter. The workman in charge proposed facilitating the process by shovelling the powder direct into the hot furnace, and then ramming it down: on trying this the first shovelful exploded with great violence, and drove the blade of the shovel into the roof of the building.

There are many other papers on fulminates, &c., which are noted and commented upon.

In conclusion, we think the following extract from the *Maryland Gazette*, June 14th, 1749, is worth quoting:—"On Friday last (9th June) the gentleman who has exhibited the electrical experiments in town removed his machine off to the south side of our creek (Spa Creek?), and having set some spirits of wine in a small vessel on a table on the north side, he caused a spark of electrical fire to dart across in an instant through 200 yards of water, which set the spirits in a blaze the first attempt, and several times afterwards, and discharged a battery of eleven guns, to the surprise and great satisfaction of the spectators." The gentleman's name is not given.

CORRESPONDENCE.

THE NATURE OF SOLUTION.

To the Editor of the Chemical News.

Sir,—In the report of the Proceedings at the last meeting of the Chemical Society, which appeared in the Chemical News, vol. lv., p. 136, Dr. Nicol is represented as stating that I have "abandoned the definite hydrate theory" of solution. Dr. Nicol misunderstands me very much if he imagines this to be the case. In a large number of cases a definite hydrate is undoubtedly formed by the addition of a small amount of water to a salt, and it has certainly not yet been proved that a further addition of water decomposes this compound; therefore, I believe that it, or some higher definite hydrate, exists in the liquid in most cases. Neither do I believe in indefinite hydrate-aggregates, as Dr. Nicol states, but in what is a very different thing, hydrates of so complex a character and so easily dissociated that our imperfect methods of investigation fail to reveal their definiteness. A belief in complex compounds of such a nature does not imply a disbelief in definite molecular compounds, any more than a belief in these molecular compounds implies a disbelief in the atomic compounds of which they are composed.

There may, perhaps, not be any great difference between Dr. Nicol's views of solution and my own, but I fear we shall not agree so long as we hold such different views as to what the hydrate theory means, and as to the nature of chemical compounds in general. Dr. Nicol appears to regard the hydrate theory to represent the solution as containing the salt in the same state of hydration as it is known in the solid state, the hydrate being perfectly stable and never partially dissociated; whereas, I take the theory simply to mean that dissolution is the result of the chemical combination of the salt with the water, the compound formed being possibly identical with the solid hydrate, but probably not so, probably much more

complex, and never entirely free from dissociation. Dr. Nicol appears to regard a chemical compound as an aggregate of molecules containing but a few atoms, always stable, and which must always necessarily give evidence of its compound nature when examined in any way, and from any point of view. I, on the other hand, admit as a chemical compound a substance which, when examined from any one point of view, gives unmistakeable evidence that it is not a mere mixture, and I know of too many instances of well authenticated compounds, which have never been isolated, which are always partially dissociated, and which, in some respects, behave as if they were mere mixtures, to accept negative evidence of this nature, as proving that this substance is *not* a compound. Dr. Nicol asks me at what number of molecules or atoms I draw the line for chemical combination. I draw a line nowhere. I have no prejudices or preconceived ideas which would stand in the way of my accepting a compound containing many millions of atoms, provided always that the evidence in favour of its being a compound were sufficiently strong.—I am, &c.,

SPENCER PICKERING.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 10, March 7, 1887.

Direct Fixation of the Gaseous Nitrogen of the Atmosphere by Vegetable Earths, with the Assistance of Vegetation.—M. Berthelot.—In the author's experiments there has taken place a fixation of nitrogen in a considerable proportion in sands and clayey soils, as well as in vegetable mould properly so-called, when he operated in the absence of vegetation, and in the soil and the plant taken collectively when the experiments are conducted in the presence of vegetation. The vegetation, however, seems to consume a part of the nitrogen fixed by the soil. The life of the higher plants, like that of animals, gives rise to an incessant loss of combined nitrogen.

Spectra of Sparks from Thick Wire Coils.—E. Demarçay.—In a former memoir the author has stated that the spectra in question, judging from those of the alkaline metals, are arc-spectra. This conclusion is not accurate for all substances. On comparing these spectra, in the region less refrangible than $\lambda = 330$, with those described by Messrs. Liveing and Dewar, the author finds that the spectra of potassium, sodium, thallium, and aluminium seem identical. Those of barium, strontium, and calcium seem approximately identical in the intensities of the rays. The spectra of tin, lead, and mercury, on the contrary, are very different, and do not resemble those given by Messrs. Hartley and Adeney. Judging from the visible portion they differ generally from those described by M. Lecoq de Boisbaudran.

The Laws of Dissolution.—H. Le Chatelier.—A reply to a memoir by MM. Chancel and Parmentier. The author recalls the fact that the law of solution which he announced is only an approximation, based upon a certain number of experimental laws more or less exact.

Certain Formulæ relative to Saline Solutions.—M. Duhem.—A discussion of the formulæ of Kirchhoff, Le Chatelier, and Wüllner.

An Especial Case of Solution.—F. Parmentier.—In general, if a solid is dissolved in a liquid, when the complete liquefaction of the solid has been effected, we may add to the solution any excess whatever of the solvent without the mixture ceasing to be homogeneous. If we dissolve phospho-molybdic acid or silico-molybdic acid in common ether it is found that at a given temperature solution takes place only between definite quantities of acid and of ether. If once these acids are dissolved in a suitable quantity of ether any excess of the solvent does not mix with the solution.

An Acid obtained by the Action of Potassa upon a Mixture of Acetone and Chloroform.—R. Engel.—The acid in question has the formula $C_{11}H_{20}O_6$. Its formula corresponds to the condensation of 3 mols. acetone with fixation of two groups COOH and loss of oxygen.

Synthetic Researches on Certain Derivatives of Diphenyl.—P. Adam.—The products obtained are diphenyl-diphenylacetone and diphenyl-methyl-carbonyl.

Active Camphene and Ethyl-Borneol.—G. Bouchardat and J. Lafont.—The camphene obtained in the first treatment has a rotatory power of about $\frac{2}{3}$ of that possessed by the terecamphenes already obtained. The combined action of a temperature of 150° at the outset and 175° at the end, and of acetic acid and potassium acetate, rapidly reduces the value of the rotatory power. The ethylate of camphene is probably an ethyl-borneol identical or isomeric with that of Baubigny.

Action of Ethylene Bibromide upon the Alkaline Alcoholates: Preparation of Acetylene.—M. de Forcrand.—A thermo-chemical paper which does not admit of useful abstraction.

Formation-Heat of Tartar Emetic.—M. Güntz.—This compound is produced with absorption of heat, its formation-heat being $-0{\cdot}85$ cal.

Journal für Praktische Chemie.
New Series, Vol. xxxv., Parts 1 and 2.

Researches from the Chemical Laboratory of Prof. Alexander Saytzeff, of Kasan.—These investigations comprise memoirs on methoxy-diallylacetic acid and its salts by S. Barataeff; on the action of a mixture of iodallyl, iodethyl, and zinc upon oxalic ethyl-ether, by the same author, and on the acetic ether obtained by the action of silver acetate upon tetra-brom-diallylcarbinol acetate, by W. Dieff.

Calorimetric Researches.—F. Stohmann.—We have here two treatises; one by F. Stohmann, P. Rodatz, and W. Herzberg on the thermic value of the ethers of the phenol series, and the other, by the same authors, on the thermic value of the homologues of benzol.

Solubility of Gypsum in Solutions of Ammonium Salts.—S. Cohn.—The question whether the irregular solvent action of ammonium nitrate upon gypsum, observed by Haver-Droeze is a peculiarity of the ammoniacal salts must be answered in the affirmative for ammonium chloride and nitrate, but in the negative for ammonium sulphate. The cause of this difference is to be sought in the possibility of a chemical transformation with the gypsum. Ammonium sulphate increases the solubility of gypsum probably by the formation of readily soluble double salts. Ammonium chloride, nitrate, and acetate increase the solubility of gypsum by mutual decomposition, with the formation of readily soluble calcium salts; the formation of double salts comes here less into play. The action of ammonium salts capable of double decomposition with gypsum increases with decreasing concentration. The solubility of gypsum is greatest in solutions of ammonium acetate; then follow the nitrate, the chloride, and lastly the sulphate.

Contributions to the Chemistry of Manganese and Fluorine.—Odin T. Christensen.—The author has already communicated the main results of his researches on the manganese double fluorides. He now describes the whole investigation more fully, and in particular the behaviour of the manganese oxides with hydrochloric and hydrofluoric acids.

The Synthesis of Kyaphenine.— Peter Klason.—The author concludes that as kyanmethine and kyanurethine, in consequence of their analogous formation, have the same constitution as kyaphenine, the polymeric nitriles may be regarded as true cyanuric compounds.

Remarks on the Foregoing Memoir.—E. von Meyer. —The author rejects Herr Klason's conclusion that the three bases in question must have analogous constitutions on account of their origin.

Apparatus for Determining Carbonic Acid and all Similar Gases.—Prof. Dr. R. Bauer.—This paper requires the accompanying figure.

Behaviour of Acetic Acid and some of its Derivatives with Phosphorus Pentachloride.—A. Michael.—Not adapted for useful abstraction.

MISCELLANEOUS.

Chemical Society.—At the Anniversary Meeting, held on the 30th of March, the following gentlemen were elected Officers and Council of the Chemical Society:—

President—W. Crookes, F.R.S.

Vice-Presidents who have filled the office of President—Sir F. A. Abel, C.B., D.C.L., F.R.S.; Warren De la Rue, D.C.L., F.R.S.; E. Frankland, D.C.L., F.R.S.; J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; A. W. Hofmann, D.C.L., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, Ph.D., F.R.S.; Sir Lyon Playfair, Ph.D., K.C.B., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents—J. Dewar, M.A., F.R.S.; David Howard; H. McLeod, F.R.S.; Ludwig Mond; C. Schorlemmer, Ph.D., F.R.S.; W. A. Tilden, D.Sc., F.R.S.

Secretaries—H. E. Armstrong, Ph.D., F.R.S.; J. Millar Thomson, F.R.S.E.

Foreign Secretary—F. R. Japp, M.A., Ph.D., F.R.S.

Treasurer—W. J. Russell, Ph.D., F.R.S.

Members of Council—T. Carnelly, D.Sc.; M. Carteighe; A. H. Church; Frank Clowes, D.Sc.; P. F. Frankland, Ph.D.; R. J. Friswell; E. Kinch; R. Messel, Ph.D.; H. F. Morley, M.A.; J. A. R. Newlands; W. Ramsay, Ph.D.; Thomas Stevenson, M.D.

Water Analysis for 2s. 6d.—A correspondent sends us the following cutting from the "Correspondence'" column of a weekly contemporary:—"*Analysing Water.* —If 'Midge' were quite a genius it might be worth while to tell him how to conduct this process, but it is doubtful if he would succeed the first time he tried. A more simple way would be for him to procure a new glass bottle (with a new cork) and fill it with the suspected water, take this bottle to the best chemist's shop in a good town, ask for a rough analysis, and offer 2s. 6d. The proper fee for this is a much larger sum, but the chemist will probably accept the offer and do all that is required.—H. Barnaby."

Nickels's Improved Filtering-Funnel.—In devising this new form of funnel Mr. Nickels has undoubtedly conferred a great boon on practical chemists, inasmuch as the time occupied in filtering is by its means very considerably reduced, thus facilitating what is very often a long and tedious operation. Some of the funnels are made so that they can be employed with a filter-pump. They also answer very well as an "Osmogene apparatus," all that is required being to fold the parchment paper in the form of a filter-paper, and to connect a piece of india-rubber tube and a stopcock to the outlet; the liquid to be dialysed is then poured into the inner funnel, and the outer jacket is filled with distilled water. As the water becomes charged with the products of diffusion it may be drawn off at frequent intervals, and replaced by a fresh supply, thus minimising the quantity of water necessary, a most important and essential condition of the operation.

MEETINGS FOR THE WEEK.

Monday, 4th.—Medical, 8.30.
—— Royal Institution, 5. General Monthly Meeting.
Tuesday, 5th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
Wednesday, 6th.—Geological, 8.
Thursday, 7th.—Chemical, 8. "Researches on the Constitution of Azo- and Diazo-Derivatives; Diazo-Compounds. Part II.," by R. Meldola, F.R.S., and F. W. Streatfeild.
—— Mathematical, 8.

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THE CHEMICAL NEWS.

VOL. LV. No. 1428.

ON COLOUR TESTS FOR STRYCHNINE AND OTHER ALKALOIDS.

By CHARLES L. BLOXAM.

THE following characteristic and delicate test for identifying strychnine does not appear to have been noticed.

The alkaloid, on a glass slide or a porcelain crucible lid, is dissolved in a drop of dilute nitric acid, and gently heated; to the warm solution a very minute quantity of powdered potassium chlorate is added, which will produce an intense scarlet colour; one or two drops of ammonia will change this to a brownish colour, giving a brownish precipitate; the mixture is then evaporated to dryness, when it leaves a dark green residue, dissolved by a drop of water to a green solution, changed to orange-brown by potash, and becoming green again with nitric acid; these last changes of colour may be repeated any number of times.

The green colouring-matter is evidently a product of the action of ammonia upon the scarlet body, for if this be bleached by heating or by excess of chlorate, before the ammonia is added, the residue on evaporation is light brown, and yields with potash a bright yellow solution which is nearly bleached by nitric acid.

No other of the commonly occurring alkaloids which I have tried could be mistaken for strychnine by the above test, but each of them exhibits some peculiarity when treated in the same way, which would give a clue to its identity. This will be seen in the subjoined Table, in which the tests are supposed to be applied to the same portion of the alkaloid, as described above.

	HNO_3.		$KClO_3$.	NH_3.	Residue.	KHO.	HNO_3.
	Cold.	Heated.					
Strychnine	—	Pink.	Scarlet.	Brownish precipitate.	Green.	Orange.	Green.
Brucine	Violet; scarlet.	Yellow.	Yellow.	Bright yellow.	Green.	Dark brown.	Green; brown.
Narcotine	—	Bright yellow.	Yellow.	Dark brown.	Dark brown.	Dark brown.	Reddish yellow.
Morphine	Orange-red.	Yellow.	Yellow.	Red-brown.	Light brown.	Light brown.	Light brown.
Quinine	—	—	—	Green precipitate.	Light brown.	Light brown.	Light brown.
Cinchonine	—	—	—	White precipitate.	Light brown.	—	—
Caffeine..	—	—	Pale yellow.	Bleached.	Red; yellow.	—	—

Some few months ago I drew attention, in the CHEMICAL NEWS, to the use of bromine-water in the detection of alkaloids. I find that a more convenient reagent can be made by mixing a weak solution of potassium chlorate with enough strong hydrochloric acid to turn it bright yellow, and enough water to make it very pale yellow. This *euchlorine* solution is added by degrees to the solution of the alkaloid in HCl, which is boiled after each addition.

Strychnine gives a fine red colour, bleached by excess and returning when boiled.

Brucine gives a violet colour, in the cold, which is bleached by excess and restored by boiling.

Narcotine gives a bright yellow colour in the cold, which becomes pink on boiling and adding more of the euchlorine solution.

Quinine gives a faint yellowish pink on boiling.

After cooling the solution weak ammonia is gradually added.

Strychnine gives a yellow colour unchanged by boiling.

Brucine gives the same.

Narcotine gives a dingy green, becoming brown on boiling.

Quinine gives a bright green, becomining yellow on boiling.

Morphine gives no reaction; but if, after boiling with the euchlorine solution, the liquid be cooled and allowed to remain in contact with zinc for a minute or two, it will give the characteristic pink reaction with ammonia.

King's College, London,
March, 1887.

RECENT RESEARCHES ON THE ACTION OF NITROGEN ON THE METALS IRON, COPPER, NICKEL, COBALT, &c.

By H. N. WARREN, Research Analyst.

THE following is a description of the action of nitrogen on the more common metallic elements. The experiments being performed as follows:—Taking in the first instance the case of iron, finest merchant iron was selected in the form of puddled bars varying from a ¼ of an inch to 6 inches thick, and divided into lengths of about half a foot respectively, each piece being inserted in strong clay tubes or pipes, the one end being connected with an apparatus evolving pure dry ammonia gas. It was raised to a bright red heat by placing it horizontally across a charcoal furnace, the first sample being maintained thus during the passage of the ammonia gas for the space of two hours. Having been cooled in the ammoniacal atmosphere it was removed, and examined as to its properties both physically and chemically. The most striking physical properties were its intense whiteness of surface and its increased hardness, not admitting of being scratched so readily by means of a file. Its malleability was next determined by securing a bar of the same in a vice, leaving about half an inch projecting, and on applying a somewhat sharp blow it broke with a decided crystalline structure, exhibiting a fracture in all respects like that of siliconised steel. The bar was next submitted to longitudinal pressure, and broke under the hammer, or, in other words, split longitudinally, in so doing dividing into segments, and exhibited a somewhat malleable but at the same time a peculiar and highly crystalline structure; both determinations having been performed after cooling.

The bar was lastly submitted to careful analysis; qualitatively giving evidence of the presence of nitrogen through the formation of ammonia, this was quantitatively standardised by means of Nessler's reagent, the average of several results showing the sample to contain approximately about 0·004 per cent of nitrogen.

A second sample was submitted, under similar treatment, to four hours' action of the ammonia gas, and on the same tests being applied it proved to have increased twofold, both as regards its physical and chemical properties, breaking transversely with a fracture decidedly more crystalline and cleaving more readily longitudinally. The analytical determination of nitrogen was approximately 0·01 per cent.

Four similar bars were next treated, the action varying from six to twelve hours respectively; the last two were submitted to ten hours' action, and gave almost identical results with that of twelve hours, having become exceedingly brittle, breaking transversely on falling from a height of 6 feet, and containing upwards of 0·5 per cent of nitrogen.

A similar bar was next treated, being raised to a full white heat by means of a powerful fan machine, but gave identical results with respect to the percentage of nitrogen, &c. The experiment was next modified by substituting anhydrous protochloride of iron in place of the iron bar: volumes of ammonium chloride were at once evolved, and a silvery spongy mass of nitride of iron remained, containing upwards of 4 per cent of nitrogen. This, on being exposed to the atmosphere, in the course of a day or two became entirely converted into ferric oxide,—resembling the former specimens, though in a more marked degree.

These experiments were next varied by substituting copper bars for those of iron, the results being almost identical both in physical and chemical properties; presenting a highly crystalline surface, combined with a crystalline fracture and extreme brittleness, the percentage of nitrogen increasing according to the duration of the action. A somewhat peculiar phenomenon was observed on bringing several of these bars into the atmosphere before they were quite cold, several of the bars splitting transversely somewhat violently, they having apparently absorbed a quantity of the ammonia gas when at a high temperature and ejected it again on cooling; similar to the absorbing power of silver on oxygen.

An amorphous nitride of copper may be also formed as follows:—Pure dry cupric oxide, CuO, is introduced into a combustion-tube and connected with an apparatus for evolving dry ammonia gas; on the application of a gentle heat water is formed abundantly, and an amorphous green powder of copper nitride remains. Care must be taken so as not to allow of the tube becoming dull red, otherwise the nitride is decomposed with violence into metallic copper and nitrogen gas. An almost identical reaction takes place in the case of mercuric oxide when treated similarly, but in this case the heat must not be allowed to exceed 400° F., otherwise the nitride explodes with fearful violence, the compound resembling in all respects, as far as analytical results can be attained, ordinary fulminating mercury.

When chromium, nickel, cobalt, or manganous oxides were employed a corresponding nitride of the metal was obtained: it is, however, generally more advantageous in the case of chromium, &c., to use a chloride of the same. No such reaction, however, appears to take place when either the metal or the oxide of a metal—such as tin or stannic oxide, zinc or zincic oxide—are similarly treated. I have, however, formed small quantities of nitride of zinc by bringing zinc into solution by means of electro-dissolution, using an ammoniacal salt as a solvent. All the nitrides produced by these means apparently closely resemble one another with regard to their stability, resolving themselves into their component parts on the application of heat; their great brittleness also renders them absolutely unfit as commercial products.

TITANIUM CARBIDE IN PIG-IRON.

By PORTER W. SHIMER, Easton, Pa.

On completing the filtration of a solution of pig-iron in hydrochloric acid, and after apparently everything had been transferred to the paper, a minute residue was observed remaining in the angle of the beaker in which the solution had been made. This residue had a steel-grey colour and metallic lustre, and was hard and gritty when touched with a glass rod. Placed under a microscope and magnified 400 diameters, the substance was found to be made up almost entirely of opaque cubical crystals with some fragments having the same colour and lustre as the cubes. The appearance was strikingly like that of a collection of crystals of iron pyrites.

The amount of material obtained—from 10 to 20 grms. of borings by solution in dilute hydrochloric acid, and careful decantation from graphite—was barely sufficient for a microscopic slide. A qualitative test of the minute amount of material obtained in this way showed the presence of considerable titanium. After many fruitless trials by decantation and other methods, sufficient material for quantitative analysis was finally obtained in the following manner:—

Two hundred and fifty grms. of the coarsest possible borings were dissolved in 7 litres of hydrochloric acid, of sp. gr. 1·03. A solution by the aid of heat took four to five hours. It was allowed to settle, and the clear solution poured off. Great care was taken that none of the material which had settled to the bottom was lost. The graphitic residue was then completely transferred upon fine bolting-cloth, previously stretched and fastened over the top of a beaker. All graphitic lumps were broken up by the finger while directing a strong stream of water from a wash-bottle upon it. When all but the larger graphite scales had passed through, the bolting-cloth was removed. This treatment separates the larger particles of graphite, which are troublesome in the subsequent separation, gives the particles more nearly a uniform size, and sets free many of the minute crystals which are to be separated. A magnet was then moved about in the liquid until all magnetic particles were removed. The material thus separated from the iron under experiment was found to be interesting, as will be shown further on.

The residue was allowed to settle into the angle of the beaker, and the liquid carefully poured off. It was then ready for the separation.

An inclined plane of window-glass, 12 feet long and 5 inches wide, was arranged in two sections, each 6 feet long, placed end to end. Narrow strips of glass, ½ inch wide, were cemented to the sides and upper end of each section. Each section was cemented firmly to a perfectly straight board about 6 inches shorter than the glass. These pieces, with the glass overlapping about 1 inch, were supported at a convenient height above a long table. For the present separation it was found that a fall of 1 inch in the first section and ½ inch in the second answered the purpose very well. A large beaker of distilled water, with syphon and stopcock, was placed at the head of the inclined plane, and water allowed to drop slowly upon it. By means of a camel's-hair brush the water was directed in a narrow stream, about 1 inch wide, throughout the whole length of the plane. Where the glass overlapped, a short glass rod was placed to lead the water to the lower section. At the end the water was led into a beaker by means of a long glass rod. The graphitic residue was then transferred to the head of the inclined plane with as little water as possible, and water allowed to drop slowly from the syphon.

The water at once begins to carry off the lighter and finer particles. It is necessary to keep tapping the residue with some convenient object, such as a platinum spatula, so as to prevent any graphite from being retained by the heavier crystals, and to keep the current flowing evenly over the whole residue. The separation soon becomes

apparent, the graphite being carried forward faster than the heavier crystals.

At this stage it is necessary to remove with a magnet any remaining magnetic particles, since these interfere with the separation. When, after three or four hours, all the graphite had been washed from the inclined plane, the water was drained off and the residue allowed to dry. When dry it formed a stream of bright metallic lustre throughout the whole length of the plane. The material was then swept together and treated in a beaker with hot hydrochloric acid, of sp. gr. 1·12, for the removal of a little iron. It was then again placed upon one of the sections of the inclined plane, and any remaining graphite separated from it. This second separation is not nearly so tedious as the first. Several separations of 250 grms. each were made, and about 1 grm. of pure material for analysis was obtained.

In the case of the iron under experiment it was necessary to have the borings as coarse as possible. In this way the scales of graphite are not so much broken up, and more can be separated by the bolting-cloth. The crystals also are less broken. When fine borings were used it was not possible to get a satisfactory separation on the inclined plane; for the small particles, instead of being independent of each other, as when coarse borings are used, gathered together in little clumps enclosing the crystals sought, which were thus carried off and lost.

The solution and separation should also be made on the same day; for when a solution is allowed to stand longer than necessary to settle there is a minute separation, perhaps of gelatinous silica, which interferes with the freedom of motion of the particles, causing them to gather in clumps, as described.

In the case of another pig-iron on which some preliminary experiments were made, the substance to be separated was still more finely divided than in the present case. It was here found best to give little, if any, fall to the plane, and to regulate the separation by means of the current of water. Successful separations were made with an inclined plane only 8 feet long.

A separation was also attempted upon a slowly revolving circular piece of glass 2 feet in diameter. The substance to be separated was placed in the centre of the glass and water dropped slowly upon it. It was thought that the water would carry the graphite to the periphery of the glass, leaving the heavier crystals in the centre. Only a little material could be separated in this way; but this result was plainly due to the fact that the glass used could not be made perfectly level. The great difference between the specific gravity of the crystals and graphite naturally suggests the usual separation by means of a dense solution; but the material is far too finely divided for successful separation by this means.

The material separated on the inclined plane, when deposited from water and dried, has a brilliant lustre and steel-grey colour. When swept together the mass has a deep iron-grey colour and little lustre. The lustre in the former case is due to the fact that, when allowed to deposit from water, the cubes arrange themselves unanimously with their faces upward, thus reflecting light uniformly.

On examining the material for analysis under the microscope, it was found to be free from graphite and to consist almost entirely of cubes, a large proportion of which were perfect. A few of the cubes had long handle-like projections from one of the angles. There were also occasional long, slightly tapering, nail-shaped crystals. The cubes varied in size from 1-1500th to 1-7000th of an inch (0·0169 to 0·0036 m.m.).

The material analysed has a specific gravity of 5·10. It is insoluble in hydrochloric acid, but readily soluble in nitric acid. The insolubility in hydrochloric acid explains how titanium in pig-iron is found and determined in the residue insoluble in this acid. The solubility in nitric acid shows how the titanium is eliminated in the nitric and sulphuric acid method for the determination of silicon in pig-iron. It is apparently wholly unattacked by a strong boiling solution of caustic potassa. When ignited for several hours, at a bright red heat, in a current of hydrogen, it suffers no change of weight. The following is the analysis:—

Titanium	71·58
Carbon	16·94
Iron	3·77
Phosphorus	0·69
Manganese	0·16
Sulphur	1·57
Silicon	0·00
Nitrogen	0·00
Insoluble siliceous residue	1·09
Undetermined	4·20
	100·00

The substance also contains a small undetermined amount of copper and vanadium, possibly in combination with sulphur. About 88 per cent of the material is thus seen to be a titanium carbide in which titanium and carbon are present in very nearly the exact proportion of their atomic weights. The formula is therefore TiC. In the calculation 48 was used as the atomic weight of titanium. The slight excess of titanium may easily exist in other combination. This compound is probably new, for I have not been able to find mention anywhere of any simple compound of titanium with carbon. The iron and phosphorus in the analysis are due to an admixture of the difficultly soluble phosphorus compound described below.

Determinations of titanium and carbon were made by various methods. In the first method dry chlorine gas was passed at a red heat over the substance contained in a weighed porcelain boat. The volatile chlorides were passed through numerous bottles and bulbs containing water. Titanic acid was separated from this solution and purified in the usual way. The carbon remaining in the boat was burned in a current of oxygen after first being freed from chlorine by passing hydrogen over it at a red heat. In another analysis the substance was burned directly in oxygen, the carbon thus determined agreeing closely with the first determination. The residue remaining in the boat was fused with potassium bisulphate, and the titanic acid separated in the usual manner.

I have found cubical crystals like those described in every one of five or six pig-irons that I have examined, one of them being a sample of English Bessemer pig-iron marked Barrow No. 1; but in none were they so free from admixture of the nail-shaped and other crystals as in the iron under experiment. This iron was a fine sample of No. 1 foundry iron, having the following composition:—

Phosphorus	0·343
Silicon	2·690
Sulphur	0·047
Manganese	0·594
Titanium	0·203
Graphite	3·664
Combined carbon	0·111
Iron (by difference)	92·348
	100·00

The titanium was determined in this iron by three different methods:—

1. The residue insoluble in dilute hydrochloric acid was fused with potassium bisulphate, and the titanic acid separated in the well-known manner. The result was 0·199 per cent titanium.

2. The residue insoluble in dilute hydrochloric acid was treated with nitric acid with the intention of dissolving out the titanium carbide,—a method suggested by this investigation. The nitric acid solution was precipitated by ammonia, the precipitate filtered, washed, and

re-dissolved in dilute sulphuric acid, and the solution boiled after neutralising excess of acid and adding sulphurous acid. The precipitate thus obtained was fused with sodium carbonate, extracted with water, and filtered. The insoluble sodium titanate was dissolved in sulphuric acid, and re-precipitated. The result was 0·206 per cent titanium.

3. Dry chlorine gas was passed over the borings at a red heat, and led through bottles and bulbs containing water. The result by this method was 0·205 per cent titanium.

It was found that in each of these three methods the first precipitates by boiling always contained phosphoric acid to such an extent as to cause very serious error when not separated. It was necessary, therefore, in each case to fuse the first precipitate with sodium carbonate and extract with water, thus separating soluble sodium phosphate from insoluble sodium titanate.

When properly carried out, the chlorine method certainly gives all the titanium in pig-iron. As much titanium was, however, found in the residue insoluble in hydrochloric acid by the first two methods as was found in the borings by the chlorine method. This proves that all the titanium, in this iron at least, is found in the residue insoluble in hydrochloric acid. It seems fair to conclude, then, that the titanium, instead of being uniformly dissolved in this iron, is mechanically disseminated through it in the form of a definite crystallised compound with carbon.

That part of the residue insoluble in dilute hydrochloric acid removed by the magnet was found to contain considerable phosphorus. It is not completely insoluble, even in very dilute hydrochloric acid, for on long boiling it dissolves. It is a finely divided granular substance, has a metallic lustre, and is so brittle that it may readily be ground to dust in a mortar. It encloses considerable titanium carbide. Samples separated at different times contained phosphorus as follows:—10·32, 12·50, and 11·90 per cent. These varying results are due to varying conditions of time, temperature, and strength of acid. One of the samples contained 69·48 per cent of metallic iron. When only slightly heated, apparently not much above the boiling-point of water, partial oxidation takes place, a bright glow spreading over the whole mass. On further heating the substance fuses easily. The compound appears to be completely insoluble in double chloride of copper and ammonium.

Duplicate determinations of the phosphorus remaining insoluble in a solution of the double chloride gave 0·155 and 0·158 per cent phosphorus. That is, 45·63 per cent of the total phosphorus in this iron remains in the insoluble residue in the form of a high-phosphorus compound!

From the residue insoluble in dilute hydrochloric acid only about 12 per cent of the total phosphorus could be separated by means of a magnet. I have not yet attempted a separation on the inclined plane of the residue insoluble in double chloride solution.

These notes on the phosphorus compound are only preliminary, for, owing to want of sufficient material, I have not been able to make a complete investigation of it.

I have great pleasure in acknowledging my indebtedness to Mr. Frank Firmstone, of the Glendon Iron Works, who not only gave me the facilities of a large iron works, but greatly encouraged me by his interest in the progress of this investigation.

Determination of Uric Acid by Means of Potassium Permanganate.—Ch. Blarez and G. Denigés.—The conditions necessary to be observed in determining uric acid by permanganate are as follows. The minimum dilution should be 1 part in 8000. The quantity of uric acid operated upon should not, if possible, exceed 0·1 grm. The quantity of free sulphuric acid should be about 3·5 grm.—*Comptes Rendus*, Vol. civ., No. 11.

ON THE

PHYSICAL PROPERTIES OF MANGANESE STEEL.*

By W. F. BARRETT

Professor of Experimental Physics in the Royal College of Science for Ireland.

At the British Association meeting in Aberdeen, in 1885, Mr. J. T. Bottomley read a brief note on "A Specimen of Almost Unmagnetisable Steel." As the magnetisation of iron was a subject on which I had worked for some time, Mr. Bottomley was good enough to hand over to me this remarkable specimen of steel for further investigation, at the same time giving me the name and address of Messrs. Hadfield and Co., Steel Founders, of Sheffield, the patentees and manufacturers of this steel.

Upon writing to Messrs. Hadfield, they furnished me with the result of a chemical analysis of their patent steel, which is as follows:—

Fe.	Mn.	C.	Si.	P.	S.
86·68	12·25	0·80	0·15	0·10	0·02 per cent.

Other varieties of this steel are manufactured, but this is the most generally serviceable. Specimens of this steel were first exhibited at the Institute of Mechanical Engineers in London in the early part of 1884, and a paper describing this material appeared in the *Engineer* for February 8, 1884. From this paper I make the following quotation:—

"It is sufficiently well known that manganese has been employed for many years in the manufacture of steel in various proportions, but anything exceeding 1 per cent, it has been generally believed, would render the metal under treatment worthless, and any further addition thereof in excess of this proportion has been considered impracticable. In fact, Dr. Siemens had stated publicly, on many occasions, that the use of manganese was simply a cloak to cover the impurities in steel making, that it covered a multitude of sins: and this was the general opinion of the steel trade. Messrs. Hadfield, of Sheffield, however, engaged in a long series of experiments and tests, with the object of discovering its truth, and after a considerable expenditure of time and capital, discovered that by adding the ordinary ferro-manganese of commerce to iron or steel in such proportions as to produce in the steel or decarbonised iron under treatment a percentage of manganese varying from 7 to 20 per cent, that the most beneficial results could be obtained. Such percentage is regulated according to the purpose for which the steel is required. For instance, to produce a steel suitable for armour-plates and other purposes, as we mentioned last week, they add about 10 per cent of rich ferro-manganese, containing, say, 80 per cent of manganese, thus obtaining a steel containing about 10 per cent of manganese. For railway purposes they add about 11 per cent, for steel toys and tools about 12 per cent. They pour this ferro-manganese into the molten steel under treatment, thoroughly incorporating it therewith, and then run it into ingot or other suitable moulds, and allow it to cool, after which it is ready for use, as it requires neither tempering, rolling, forging, nor hardening. This treatment of steel in suitable proportions, according to requirements, appears to be novel, and renders the steel so manufactured harder, stronger, denser, and tougher than most steel now manufactured, even when forged and rolled. This steel may, however, be forged and rolled in the ordinary manner. *For casting* it has the advantage that it possesses greater freedom from honeycombs and similar defects; but the most peculiar property is its great toughness, combined with extreme hardness. It is through this that the hitherto indispensable processes of rolling, forging, hammering, hardening, and tempering may be dispensed with, thus effecting for many articles an enormous economy in time, labour, and expense. In casting its fluidity enables fine steel castings to be made

* A Paper read before the Royal Dublin Society, December 15, 1886

without misrunning, and approaching in smoothness iron castings.

"Amongst the samples of the steel placed on the table at the meeting of the Mechanical Engineers was a sample test bar containing 12 per cent manganese, bent double when cold, though hard enough for turning iron; a sample from same ingot shows a tensile strength of 42 tons per square inch, with 20·85 per cent elongation; several hammered pieces; a manganese adze, containing 20 per cent manganese, just as it left the mould; an axe, containing 12 per cent manganese, just as cast in the rough, had chopped through ¼in. square iron. This, like the others, had not been hardened or tempered, only the edge ground."

In a paper read before the American Institute of Mining Engineers in May, 1884, some tests of this steel were given, showing the extraordinary tenacity and hardness of the material. When hammered or drawn into rods it loses some of its toughness, and becomes exceedingly hard.

If now the steel be heated to a yellow or nearly welding heat, and then suddenly quenched in cold water, instead of becoming harder it loses some of its hardness, and becomes exceedingly tough, so that the effect produced upon manganese steel is just the opposite to that produced upon ordinary steel, which is of course rendered hard and brittle by sudden cooling.

It was important for the purpose of my investigation to obtain a specimen of manganese steel drawn into wire, and Messrs. Hadfield endeavoured to draw some for me. In this they did not at first succeed; so I begged Messrs. Rylands, of Warrington, whose extensive wire-drawing works are well known, to make the attempt. They were good enough to oblige me, and, after several ineffectual trials, wrote:—"We gave the steel into the hands of our most experienced wire-drawer, a man who is accustomed to draw crucible steel wire; but he says that although he gave it every facility, putting only half a size on to it, the steel will not draw at all." After much time had been lost in these attempts, Messrs. Hadfield, at my request, once more undertook the task themselves; and I am glad to say they have now been completely successful. The specimens here exhibited for the first time are long lengths of manganese steel wire, No. 13 S.W.G., and also No. 19 S.W.G., of two kinds, hard and soft. I requested Messrs. Hadfield to let me know the method of wire-drawing they found successful, and the following is their account of the process adopted in drawing manganese steel into wire:—

"When first trying to reduce this material from the rolled rods into wire, it was attempted to draw it straight away from the rods; but, owing to its hardness, very little progress could be made, as the wire kept breaking in short lengths. Several methods were tried, such as softening it by annealing, as in ordinary wire; but this seemed to make very little difference.

"As exceedingly good bending tests had been obtained with bars of the same steel when heated to a yellow heat, and plunged into cold water, it was thought worth while attempting a similar experiment with the rolled rods before trying to draw it down into wire. The rods were coiled up, heated to a yellow heat over a smith's fire, and then plunged into cold water. It was then easily drawn into wire, starting with No. 7 gauge, when it was drawn to No. 9 with safety. This drawing again took out the requisite ductility, and it was therefore necessary to again heat the wire, and plunge it in the same manner as before. By doing this each time the wire was reduced two numbers of the gauge; there was no difficulty whatever in drawing it to any desired fineness, the only point necessary being that the wire must be heated sufficiently hot before plunging into cold water, or the wire would be still too hard. The colder the water the better the result."

The composition of the manganese steel from which the wire was drawn is slightly different from the specimen I obtained from Mr. Bottomley. The analysis of the wire is as follows:—

Iron.	Manganese.	Carbon.	Silicon.	Phos.	Sulphur.
84·96	13·75	0·85	0·25	0·10	0·09 p.c.

I have now to lay before the Society the results of some of my experiments with this material:—

Density.—The density of the manganese steel wire I find is 7·81, that of ordinary steel being 7·717.

Hardness.—In its ordinary condition manganese steel is very hard. It easily scratches steel that is not hard-tempered.

Modulus of Elasticity.—The modulus of elasticity (Young's Modulus) was determined by direct stretching. Experiments were made with the ordinary hard manganese steel wire and with the same wire annealed by sudden cooling. A length of four metres was suspended from a well-constructed clamp of a new form, devised and made for me by Messrs. Booth Brothers, of Dublin, and the readings were taken by an excellent cathetometer. The flexure of the support under the maximum stress was carefully tested and found to be inappreciable. An initial weight of 2000 grammes was kept on the wire, and additions were made of 10,000 up to 40,000 grammes; with the maximun weight there was no set, the index accurately returning to zero when the weights were removed. Three elongations were made in each of five sets of observations, the mean of the fifteen trials giving a modulus of 16,800 *kilogrammes per square millimetre*. Another set of observations were made with an initial stress of 5000 grammes; adding to this 38 kilogrammes, on and off, the mean of three sets of observations thus made gave a rather higher number, namely, 17,130 kilogrammes per square millimetre.

Mr. M'Cowan, B.Sc., the Demonstrator in Physics at the College of Science, also took a set of careful observations; the number he independently obtained was somewhat lower, namely, 16,470 kilogrammes per square millimetre.

The mean of these three series of experiments is the same number as the mean of the first fifteen experiments, viz.:—

16,800 kilogrammes per square millimetre,

or 1680×10^6 grammes per square centimetre, which may be taken as the modulus of *hard manganese steel wire*. The diameter of the wire used was 0·98 millimetre, and the length under observation 3·455 metres,

The *soft* manganese wire was now tried. Six sets of experiments were made with three or four elongations in each, the mean of twenty elongations giving a modulus of

16,710 kilogrammes per square millimetre,

slightly below that of the hard wire.

These numbers are lower than I expected. Iron has a modulus of 18,610 kilos. per square millimetre. Steel wire varies from 18,810 up to pianoforte wire, which is 20,490 kilogrammes per square millimetre.

But this comparatively high rate of extensibility of manganese steel is for many purposes a considerable advantage, as it enables the material to give under a sudden stress without fracture.

(To be continued).

PROCEEDINGS OF SOCIETIES.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Annual General Meeting, March 14, 1887.

Address of the President, Dr. Odling, M.A., M.B., F.R.S., &c.

By the provisions of the Royal Charter under which the Institute of Chemistry was incorporated on the last day of June, 1885, it was required among other things that the Institute should with all reasonable expedition, by resolution of a General Meeting, make bye-laws for regulating

the conduct of the affairs and property of the corporation; that the bye-laws so made by the Institute should not have effect until they had been submitted to and allowed by the Lords of Her Majesty's Privy Council; and that until the bye-laws had been so allowed, the affairs of the corporation should be conducted by the first appointed Council of the Institute in accordance with the Articles of Association of the original Institute founded in October, 1877, so far as they were not inconsistent with any express provision of the Charter. As regards the provision of the Charter declaring that the bye-laws of the Institute should not have effect until they had been allowed by the Lords of the Privy Council, I have the satisfaction of being able to inform you that these bye laws, as made by resolution of a General Meeting held on February 4th, 1887, confirmed at a subsequent General Meeting held on Feb. 15th, 1887, received, so lately as February 24th of the present year, the formal allowance of the Privy Council; so that for the last fortnight, the conduct of the affairs of the Institute has had to be, and henceforward will have to be, in accordance with the bye-laws of the Institute, now made and allowed as required by the Charter.

The bye-laws of the Institute, thus given effect to, are in the main identical with those first made at a General Meeting of the Institute held so far back as March 26th, 1886; and are based, as nearly as might be, on the Articles of Association of the original Institute. At different intervals since March 26th, three separate sets of suggestions and requirements have been put forward by the Privy Council; and though the successive consideration of these has had the disadvantageous effect of taking up a good deal of time, it must frankly be admitted that the careful criticism to which the bye-laws, as first made, have been subjected by the Privy Council, has resulted in their greater consistency and better fitness for their intended use. The final insistance by the Privy Council on one or two slight verbal alterations has caused indeed some little extra delay; but on most points their representations and requirements could not but be recognised at once as advantageous and called for; while on other points our counter-representations were eventually acceded to by them in a spirit of consideration and reasonableness demanding our thankful and hearty acknowledgment.

The bye-laws first submitted to the Privy Council, namely, those made on March 26th of last year, dealt with a proportion of the originally appointed Officers and Council of the Institute as ineligible for re-appointment by election of the Fellows, at the first General Meeting to be held under the bye-laws. It was pointed out, however, that this proposed ineligibility was contrary to the provisions of the Charter, which expressly declared the eligibility of the whole of the originally appointed Officers and Council for re-appointment by election. Thus it is that the Officers and Members of Council now holding office, together with three other Fellows of the Institute who have been most largely approved as suitable to fill the vacancies which have occurred, present themselves for election at this the first election held under the Charter and bye-laws. At every subsequent Annual General Meeting and election, however, one-third of the Vice-Presidents and Members of Council will, as heretofore under the articles of association, be ineligible for re-appointment. It being required by the bye-laws that the holding of the election and Annual General Meeting should be on the 1st of March, or on some day between the 1st and the 15th of March, the meeting has, on this occasion, been put off until the latest included date. For the announcement of the meeting having to be made before the bye-laws had been formally allowed by the Privy Council, it was thought desirable to afford the longest possible opportunity for their being so allowed before the time of holding the meeting; since in default of their being so allowed, the election of Officers and Council, which according to the provisions of the Charter can only be held under the bye-laws, and consequently not until after their allowance, could not have been held at the meeting at all, and must indeed have been postponed for another year. In future, however, it will probably be desirable to hold the Annual General Meeting and election as soon as may be after the 1st of March.

Under the provisions jointly by the Charter and the bye-laws, the Council of the Institute has entrusted to it no inconsiderable powers. It constitutes, however, but the chosen executive of the entire corporate body, who are indeed the body responsible alike for the general policy of the Institute, and the regulation, broadly, of its affairs. The desirable continuity in any course of action pursued by the Council is provided for by the circumstance of two-thirds of its members being eligible for re-appointment at each successive Annual General Meeting. The desirable renovation of the Council, and its continuance in touch with the general body is provided for by the circumstance of the whole of its members vacating office every year; by one-third of the old members being ineligible for re-appointment; and by the official nomination of one-third of the new members being left in the hands of the general body. The powers of the Council are, moreover, limited by the conditions that they are to be exercised in accordance with, and subject to the provisions of the Charter and bye-laws of the Institute; that they are to be subject also to the control and regulation of any General Meeting; and that they are not to be exercised in respect of certain matters—such as the making of bye-laws and the purchasing or erecting of any building—which, under the provisions of the Charter, require to have the sanction of a General Meeting. Doubtless, it must and will happen from time to time that the action of the Council, determined on after consideration and discussion, of representations and counter-representations brought specially under their notice, may not have the approval of individual Fellows; but it will clearly be the fault of the general body, if the general course of action of the Council, subject as it is in so many ways to their direction, is not in accordance with their prevailing wishes.

It should be fully understood that the Institute of Chemistry is essentially a professional organisation, having in view professional objects. Its primary function is not the dissemination of scientific knowledge, but the assurance of scientific attainment. It is, indeed, the organisation of a highly scientific profession; probably the most, certainly one of the most, scientific of all existing professions. And its chief purpose is to ensure and improve the scientific training of those practising the profession, by setting up a high standard of scientific proficiency, and by certifying to the attainment of such a standard on the part of its registered members. As regards persons already in practice, its attestation must necessarily be based on the evidence available that they have, for not a few years, practised their profession with approved skilfulness and good repute. Such persons may well be depended on to maintain the character of the profession, and to justify the attestation accorded them. But it is with the future of the profession, as determined by the training and character of those entering its ranks, that the Institute is chiefly concerned. The gradual elevation and advancement of the profession in general, on the one hand by the educational and other demands made on every one admitted into the corporation, and on the other hand by the inducement which admission to membership of the corporation will hold out to educated men, is the declared purpose for which the Institute was originally founded,—a purpose spoken of in the Royal Charter, under which it has since been incorporated, as "laudable and deserving of encouragement." Accordingly, in the case of all persons now entering the profession, not only are they required to show a practical familiarity with chemical operations as tested by the Institute itself, but they have in addition to furnish satisfactory evidence alike of general scientific training and general scientific attainment.

The Institute of Chemistry having been successively founded and incorporated with a view to the organisation and elevation of the chemical profession, it is

to the achievement of this object that its efforts are properly directed; and it is by the more or less full achievement of this object that it must eventually claim to be judged. Despite many difficulties, owing in the first instance to the unsuitability of its constitution to the purposes and influences it aimed at effecting, and latterly to the transitional stage through which it has passed, it has admittedly achieved no inconsiderable amount of success. From this time forward, favoured by its Royal Charter, and acting now for the first time under its own bye-laws, it starts anew on its career, with a smoother course and more hopeful prospects than ever yet lay open before it. It prefers a claim upon all engaged in the profession of chemistry to interest themselves in its welfare, and to make its now completed organisation serviceable to good ends, and a means of advancing the profession to which they are attached, and of which they feel so justifiable a pride in being accounted members.

Unfortunately, the objects which the Institute of Chemistry is intended to subserve are not such as afford occasion for frequent personal intercourse, or for the circulation of beneficial printed communications among its Fellows,—means which habitually exert so large an influence in binding members of one and the same corporation to one another, and sustaining their interest in the corporation to which they in common belong. Requirements of education, examination, attestation, and registration are not matters habitually calling forth a strong enthusiasm of grateful recollection. But in default of any such enthusiasm, the Institute, especially in the still early stages of its career, prefers a claim on its members for steady continuous accord and support. While carefully guarding the portals of the profession, it further aspires to safeguard the interests of those admitted within the precincts. It is now to a considerable extent, it looks forward to being to a far greater extent, the means of assuring to the carefully trained and honourably conducted professional chemist a recognised claim and position against which the unqualified and meretricious will feel it in vain to contend. Strongly desiderated, as it has been by many of the younger and more earnest of the profession, it appeals to the good-will and fostering interest of all; and of those, more especially, whose already assured position puts them personally beyond the scope and influence of its looked for usefulness and future success.

But the possession of adequate scientific qualification to enter a profession is one thing, the maintenance of high scientific qualification to practise the profession is another. The first named qualification, as the result of a special prescribed study, can alone be tested and attested by the Institute; the last named qualification is necessarily dependent on a voluntary perseverance in scientific study and a maintained interest in scientific progress. The advances of scientific chemistry are nowadays so rapid, and the development of applied chemistry follows so closely on the heels of scientific discovery, while pointing the way to yet further discovery, that the professional chemist, more, perhaps than any other professional man, is placed in the happy position of being bound, throughout his life, to continue a student of science, and a contributor, in one way or another, to its advancement. A student, if only for his own sake, he must be; a teacher he may be, and on many grounds it is desirable that, in some cases, he should be. With but few exceptions, some of them it is true very eminent exceptions, the leading chemists of the country are the holders of professorial positions; and would it be other than a loss to professional chemistry, and to the many great interests committed to the care and judgment of professional chemists, if practitioners and professors were to be, from the first and throughout, broadly marked off from one another? Would it, for example, be for the public advantage that Professor Williamson, Professor Frankland, Professor Roscoe, Professor Tyndall, Professor Dewar, and others, should be debarred from affording their professional services to the Board of Trade, to Royal Commissions, to the Judicature, to the Trinity House, to the Home Office, to the Board of Works, to the Board of Inland Revenue, and to other municipal or state departments? Would it again be for the public advantage that the chemists exclusively engaged in these and other departments should, in particular cases of difficulty and doubtfulness, be unable to have the professional cooperation of their professorial brethren; that the men eminent for highly specialised knowledge should, in their responsible positions, be refused, from time to time, the desired cooperation of men with a different and wider range of knowledge? Would it be for the advantage of the many large interests confided to them that the body of professional chemists throughout the land should be a body wholly apart from and not amenable to the influence of association, on an equal footing with the holders of professorial positions and recognised leaders of chemical thought in the country?

On the other hand, the gain to professorial teaching and even to investigation, from the occasional engagements of the professoriate in various branches of professional work, would seem not to admit of question. Technical chemistry is the necessary and friendly illustrative of general chemistry; and such a knowledge of technical chemistry as is only to be acquired by the responsible conduct, from time to time, of technical inquiries, is by no means the least essential item of knowledge demanded in professorial teaching. General chemistry, while distinct from technical chemistry properly so-called, has this in common with it, that it comprises a study of all the more important chemical changes taking place or effected, on a large scale, in the different processes of nature and art. It is necessary for the student to complete his chemical education by being made acquainted with these different changes and processes viewed as chemical phenomena; since by their study he is enabled to acquired a far better understanding of the nature and results of chemical change than he could possibly get by a study of laboratory processes only, conducted mostly on a small scale and with a different object. The teaching of scientific chemistry is not meant only or chiefly for those of independent means, who throughout their lives are to be exclusively students and inquirers; but is meant in large measure for those who, in some way or other, are to make their study of the principles of chemistry available for their own needs, and directly contributory to the prosperity and productiveness of the country. It is for the professor of chemistry, by that familiarity with technical operations which is attainable only by occasional participation in them and responsibility with regard to them, to make himself qualified to direct the pupil in his scientific study of technical processes, considered as among the largest and most important illustrations of chemical change. In many ways, indeed, it is for the advantage of those whom he teaches that he should not hold himself aloof from the professional pursuits for which the majority of them are qualifying themselves under his instruction and guidance. The question is not between a teacher fulfilling the special duties of his chair assiduously and earnestly, or perfunctorily and indolently; for among not the least active and renowned of teachers have been found those largely engaged, from time to time and in one way or other, in professional work. But the question is, assuming the attention of the teacher to be available in some measure for other duties, whether his duly paid for occasional engagement in the work of technical enquiry is not, at least, as cognate and professorially improving as his alike paid for, more or less continuous engagement in the not over edifying work of examinership, secretaryship, directorship, editorship, hack-authorship, and so forth. To be engaged in the profession of surgery, of medicine, of law, of engineering, and of fine-art, &c., is an almost essential requirement of the professor of each of these subjects; and to be engaged in the profession of chemistry cannot, it would seem, be otherwise regarded than as a valuable contributory qualification of the professor of chemistry. In support of this position, I would invite your attention

to the substance of a letter communicated, some time back, by Professor Frankland, to the Chemical News.* As this letter was called forth by way of reply to an elsewhere-appearing alike foolish and rancorous attack on the Institute, to which it is not worth while to accord the importance of more than a passing mention, I have persuaded Professor Frankland here and there to alter the wording of his letter, excluding from it, as far as could be, all animadversion on the little ebullition of editorial pique, to which it was only too serious a rejoinder. For editors, even professor editors, "however they have writ the style of gods," have yet their besetting frailties; tall-talking, rather than plain-dealing, being, indeed, their too delightful privilege, and ever fondly resorted to weapon, serving them both as sword and shield.

In common with other great gifts, the power of making important contributions to knowledge and doctrine is, in its very nature, a rare power. Whatever his desires, opportunities, and efforts, it is not given to everyone to be a great discoverer. But to every member of a scientific profession it is given to do good and useful work in science, and in the applications of science. More especially it is incumbent on the professional chemist to be not unmindful of, nor is he found to be unmindful of, the special opportunities afforded him. By his function and training he would seem to be of necessity an investigator; since to analyse necessarily implies to investigate. Always, indeed, should it be borne in mind that the varied work of the professional chemist, in its different degrees of magnitude, responsibility, and originality, is essentially scientific work, claiming to be conducted in a scientific spirit. As but few among us can be in, or near, the first rank of discoverers, so neither can many of us be holders of the first professional positions, and doers of the most dignified and highly remunerated professional work. But as it is for the youthful, the little heard of, and the struggling worker to pride himself on belonging to a definite learned profession, including in its ranks the most eminent and revered of his masters in science, so it is for everyone, no matter how high his position, who is, or has been, engaged in any way in professional chemistry, and takes interest in the professional career of his pupils and successors, to recognise the tie which binds him and his fellow workers together. It is for all alike to acknowledge a mutual claim on each other's consideration and good will, and a common obligation to the now organised profession of which all alike are members.

PHYSICAL SOCIETY.

March 26th, 1887.

Prof. Balfour Stewart, President, in the Chair.

Mr. Edmund van Aubel was elected a member of the Society.

The following paper was read:—

"*On the Production, Preparation, and Properties of the Finest Fibres.*" By Mr. C. V. Boys, M.A.

The enquiry into the production and properties of fibres was suggested by the experiments of Messrs. Gibson and Gregory on the "Tenacity of Spun Glass," described before the Society on Feb. 12, and the necessity of using such fibres in experiments on which Prof. Rücker and the author are engaged.

The various methods of producing organic fibres, such as silk, cobweb, &c., and the mineral fibres, volcanic glass, slag wool, and spun glass, were referred to, and experiments shown in which masses of fibres of sealing-wax or Canada balsam were produced by electrifying the melted substance.

In producing very fine glass fibres, the author finds it best to use very small quantities at high temperatures, and the velocity of separation should be as great as possible. The oxyhydrogen jet is used to attain the high temperature, and several methods of obtaining a great velocity have been devised. The best results obtained are given by a cross-bow and straw arrow, to the tail of which a thin rod of the substance to be drawn is cemented. Pine is used for the bow, because the ratio of its elasticity to its density (on which the velocity attainable depends) is great. The free end of the rod is held between the fingers, and when the middle part has been heated to the required temperature the string of the cross-bow is suddenly released, thus projecting the arrow with great velocity and drawing out a long fine fibre. By this means fibres of glass less than 1-10,000th of an inch in diameter can be made.

The author has also experimented on many minerals, such as quartz, sapphire, ruby, garnet, felspar, fluor-spar, augite, emerald, &c., with more or less success. Ruby, sapphire, and fluor-spar cannot well be drawn into fibres by this process, but quartz, augite, and felspar give very satisfactory results. Garnet, when treated at low temperatures, yields fibres exhibiting the most beautiful colours.

Some very interesting results have been obtained with quartz, from which fibres less than 1-100,000 of an inch in diameter have been obtained. It cannot be drawn directly from the crystal, but has to be slowly heated, fused, and cast in a thin rod, which rod is attached to the arrow as previously described.

Quartz fibre exhibits remarkable properties, as it seems to be free from torsional fatigue, so evident in glass and metallic fibres, and on this account is most valuable for instruments requiring torsional control. The tenacity of such fibres is about 50 tons on the square inch.

In the experiments on the fatigue of fibres great difficulty was experienced in obtaining a cement magnetically neutral, and sealing-wax was found the most suitable.

An experiment was performed illustrating the fatigue of glass fibres under torsion, and diagrams exhibited showing that the effect of annealing them is to reduce the subpermanent deformation to about 1-10th its original amount under similar conditions.

Annealing quartz fibres does not improve their torsional properties and renders them rotten.

Besides the use of quartz for torsional measurements, the author believes that quartz thermometers would be free from the change of zero, so annoying in glass ones. He exhibited an annealed glass spiral capable of weighing a millionth of a grain fairly accurately, and also a diffraction grating made by placing the fine fibres side by side in the threads of fine screws. Gratings so made give banded spectra of white light.

The author regretted that his paper was so incomplete, but thought the results already obtained would be of interest to the Society.

Prof. W. G. Adams congratulated the author on his most interesting paper, and considered the results to be of great importance. He believed the banded spectra exhibited by the grating were probably due to internal reflection within the fibres.

Mr. Cunyngham asked whether the glass mirror used in the torsional experiments was magnetic, to which the author replied that this was probable, but even this assumption did not explain all the peculiarities observed.

A paper by Prof. Pickering was postponed till the next meeting, on April 23rd.

Nitrogenous Derivatives of Turpentine.—C. Tanret.—The author has isolated two isomeric compounds having the composition $C_{20}H_{17}NO_4$. The compound α melts at 210° and boils at 283° with partial decomposition; β begins to melt at 100° and boils at 274°. Their characteristic reaction is the fine violet colour which a trace of these bodies gives with ferric salts.—*Comptes Rendus*, Vol. civ., No. 11.

* Chemical News, Dec. 18, 1885 vol. lii., p. 305.

NOTICES OF BOOKS.

The A B C of Modern (Dry Plate) Photography. By the London Stereoscopic Company, Limited. London. 1887. (Twenty-second Edition.)

The previous editions of the "A B C of Modern Photography" having been so successful, the publishers have, in issuing the 22nd edition, taken the opportunity of enlarging it by one hundred pages, and adding to the work much fresh matter which recent advances in the science have rendered desirable, if not necessary; in fact this latest edition may almost be considered to be a new book.

Part I., beginning with the choice of apparatus, gives a list of all the apparatus necessary for taking a picture, and, after commenting shortly on the time of exposure, development and fixing are thoroughly explained; in fact this, the first part of the handbook, is devoted entirely to the manipulative part of photography.

Part II. is for advanced students, and it is recommended that the reader should master the first part before attempting to go on any farther in the work. It commences with a few remarks on lenses, and points out the differences between lenses for portraits and those for landscapes, &c. Amateur portraiture is, however, generally unsatisfactory, principally on account of the operator not having a properly fitted-up studio, with all the indispensable appliances for arranging and controlling the light and shade. It seems, therefore, hardly necessary to do more than lightly touch on the subject in a book of this class, intended specially for beginners.

The chapters on photo-micrography (or, as we should prefer calling this art, micro-photography) and instantaneous photography are both interesting and instructive. Several shutters are described and illustrated, and their respective merits or demerits pointed out. The advantages of using paper negatives are next dwelt upon, not the least of which is the diminution of weight to be carried about; another is the absence of what is known as "halation," or the effects of reflection from the back surface of the glass. New apparatus and processes are finally given: the new method of printing known as the "platinotype process" is fully explained; the advantage of this process is that the pictures obtained will not fade, but are as permanent as the paper itself. Another comparatively new method of printing is the "carbon" process—a modification of which is known as the Woodbury type, by which means hundreds of copies can be reproduced at a low price.

Report of the Assistant-Chemist to the New York Agricultural Experiment Station. By E. F. Ladd. Elmira, N.Y. 1887.

During the past year Mr. Ladd has, besides the routine work of the Station, continued his examination of feeding stuffs in respect to their chemical composition and digestibility. A process of saponification promised well for measuring the digestible fat in coarse fodders, but the difficulty of filtering prevented its use with meal and similar products.

The processes used in the digestion of the albumenoids are the same as given in the last report, except that 1 grm. of the substance is always used, as it can be worked to better advantage. In order to test what effect each part of the digestive fluid has, a few experiments were made with different quantities of the fluid, and the results are given in a table: when a small quantity of starch or sugar is added, the amount digested is diminished in proportion.

In artificial digestion trials it is usual to continue the operation, after the digestion with gastric juice, by means of a pancreatin solution; but Mr. Ladd's experience with the pepsin method has failed to give such uniform or high results, on the whole, as when the pancreatin digestion was omitted. To find the degree of fineness for the best digestion a sample of corn was divided into three parts—one coarse, another fine, and the third between the two; a difference of 20 per cent was found in favour of the fine over the coarse. In a previous report Mr. Ladd has called attention to the subject of heated corn-meal, and investigations by Husemann and others have shown that such meals frequently contain a toxic principle belonging to the class of ptomaines, due to putrid decomposition of the nitrogenous portions of the corn-meal. He has now succeeded in isolating a small quantity of this poison from a sample of badly heated meal; when slowly evaporated from an ethereal solution it gave urea-like crystals. The quantity as yet obtained is not sufficient to make a proper study of the physiological effects, but the author will carry this out at the first opportunity. The ill effects sometimes arising from feeding on cotton-seed meal he suspects may be due to similar causes, but he has not yet attempted to see whether ptomaines are present or not in such cases.

Ptomaines are not confined to the food of our domestic animals, but have been found in many substances used for the food of man. When decomposition is allowed to set in before being used, serious cases of poisoning have been known to result from eating cheese and milk which were really unfit for use.

A table is given of the analyses of eighty-four grasses, hays, grains, &c., and it is noticeable that the percentage of albumenoids in the grasses are rather lower on the whole than is generally thought. This may be due to the sampling, which was done by Mr. Ladd himself, and may be considered to be as fair a sample as could be taken.

Table II. gives the results of the experiments on digestibility of the same foods; the clovers are found to be the richest in albumenoids of any of the hays, and a larger percentage is digestible. Buttercups are richer in albumenoids than daisies, and are nearly twice as digestible; but the most highly nitrogenous food of anything yet analysed is the *Soja hispida* bean, the crude albumenoids being 43·75 per cent, of which the digestive coefficient was 95·32 per cent.

Probably in no other determination in fodder analysis is there likely to be so wide a variation in the results obtained by different chemists as in the fibre: this is chiefly due to the different methods used and the temperatures employed in the determination.

Mr. Ladd gives five different methods which can be and are used in different laboratories, and the results are analysed in several tables.

The work Mr. Ladd is engaged upon will be found to be of great value to stock raisers, besides being of interest to chemists and physiologists.

CORRESPONDENCE.

TRANSPARENCY OF MOLTEN METALS.

To the Editor of the Chemical News.

Sir,—A letter appeared in your journal some weeks ago concerning the alleged transparency of molten cast-iron, and I have looked for several weeks hoping to see the statement of Dr. Ramsay either confirmed or contradicted. I would not desire to rashly contradict a statement made by one who has so many claims to be considered an accurate observer as is the case with Dr. Ramsay, but at the same time I think the alleged transparency should not be accepted as a fact without further evidence. That many metals, when at a high temperature, appear clear and transparent is well known, and as examples it is only necessary to mention silver or gold in cupellation, or copper during refining. But despite this clear bright appearance these metals are still opaque, for it is not possible to see the bottom of the cupel or

crucible through even a very thin layer of metal. If cast-iron really is transparent, it would certainly be contrary to my conceptions not only of the characters of iron itself, but also of the 10 per cent, or so, of other elements—such as carbon and silicon—which exist, probably in a state of solution, in the iron.

I have often had an opportunity of seeing tons of iron and steel poured, and never remember to have seen anything corresponding to transparency. It is not possible for the puddler to see through his bath of metal to know how his bottom fettling is wearing, neither can the foundry-man see through the metal as it pours in a thin stream over the lip of his ladle, and certainly in this latter case the metal should be transparent if at all.

Since Dr. Ramsay's letter appeared I have made fruitless endeavours to see through a stream of metal, both from a Bessemer converter and from the ladle of a Siemens furnace, while a number of my friends connected with iron-founding have been good enough to try experiments for me also, but hitherto without observing any transparency. In several instances special arrangements have been made to obtain a thin uniform stream of molten metal, behind which objects, such as tools and bricks, have been moved by an assistant. It must of course be remembered that considerable experience is necessary in viewing molten metal if accurate ideas are to be obtained, but hitherto my most experienced friends have not been able to see through a uniform thin stream of metal. Hence though I am not at present prepared to deny the truth of Dr. Ramsay's statement, still it would appear that, if molten cast-iron is transparent at all, this transparency can only be observed under exceptional conditions.—I am, &c.,

THOMAS TURNER.

Mason College, Birmingham,
April 4, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 11, March 14, 1887.

Artificial Production of the Ruby.—M. Fremy.—The author refers to his former memoir (1877) and then describes researches which he has lately undertaken in conjunction with M. Verneuil to determine the action of fluorides upon alumina. At a red heat almost all fluorides occasion the crystallisation of alumina. Calcium fluoride thus affects twelve times its weight of alumina. M. Fremy finds that alumina, even without being in actual contact with calcium fluoride, but merely exposed to the vapours given off by the latter when calcined in the air, becomes mineralised, loses its amorphous condition, and is changed into a crystalline mass.

Variations of the Absorption Spectra of Didymium.—H. Becquerel.—(See CHEMICAL NEWS, vol. lv., p. 148).

Researches on the Application of the Rotatory Power to the Study of Certain Compounds produced in Solutions of Tartaric Acid.—D. Gernez.—When tartaric acid and sodium molybdate occur in solution in equal equivalents a substance is formed having a rotatory power 37·57 times that of tartaric acid. It is, therefore, intelligible that in solutions which, for the same weight of tartaric acid, contain less sodium molybdate, the rotation is strictly proportionate to the weight of the inactive substance employed until the solution contains ½ equivalent. The addition of sodium molybdate to a solution containing already equal equivalents of the two substances produces effects which are scarcely appreciable.

A General Method of Forming Manganites, setting out from the Permanganates.— G. Rousseau.— Under the prolonged action of heat manganese dioxide reacts upon manganate, which disappears entirely after being submitted to a temperature of 240° for seven hours. The resulting mass, after repeated washing with boiling water, presents a composition approaching that of a potassium pentamanganite.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 2, January 20, 1887.

New Processes for Preparing Crystalline Carbonates.—L. Bourgeois.—The author gives two procedures in the moist way, both founded on the precipitation of a superheated saline solution by ammonium carbonate. In one method he operates at 150° to 180° upon 0·5 grm. of an amorphous precipitated carbonate reacting upon 2 grms. of an ammoniacal salt, generally a hydrochlorate in presence of 20 c.c. of water. After four or five heatings, followed by slow coolings, complete crystallisation was effected. According to the other method he heats the dilute solutions to be precipitated to about 140° along with an equivalent quantity of urea, which, at this temperature, is hydrated and converted into ammonium carbonate.

New Process for the Volumetric Determination of Zinc Powder.—F. Weil.—The author prepares a liquid of copper, of which 10 c.c. contain exactly 0·1 grm. of pure copper. To this end dry in a porcelain capsule pure copper nitrate, the ignition of which is completed over a gas-burner in a platinum crucible. The copper oxide thus obtained is let cool in the desiccator and 12·519 grms. are weighed out and dissolved in pure hydrochloric acid with the aid of heat. The liquid is then made up with distilled water to 1 litre. The normal solution thus prepared contains exactly 0·1 grm. of metallic copper in 10 c.c. By means of a pipette 50 c.c. of this liquid are transferred to a porcelain capsule. Ammonia is then added until there is formed a slight turbidity which does not disappear on stirring, though the liquid is still slightly acid. A portion of the zinc powder, weighing 0·4 grm., is let fall to the bottom of the capsule. This small heap is covered with a platinum wire coiled at its lower part into a flat spiral, whilst the stem rises up out of the bath so that the wire serves to stir the liquid. The zinc precipitates copper, equivalent for equivalent. If the operation is performed in a platinum capsule it does not last more than ten minutes. The end of the reaction is ascertained by means of a fresh piece of platinum wire, with which the powder is touched at the bottom of the capsule. If any zinc remains undissolved the wire is instantly covered with a black or red film. If the wire remains a clear white all the zinc is dissolved and the operation is completed. The platinum wire is then withdrawn and washed with the washing-bottle, and there is poured into the capsule, drop by drop, a little acetic acid to render the liquid clear. It is then decanted into a glass graduated to 100 or 200 c.c. The capsule and the deposit of copper are washed with distilled water, adding the washings to the liquid, and making up the volume respectively to 100 or 200 c.c. The whole is stirred and let settle, if needful, for some minutes. Of this liquid 10 c.c. are placed in a small flask of white glass. Two or three volumes of pure hydrochloric acid are added, and it is titrated at a boil until completely decolourised with a solution of stannous chloride, the value of which has been ascertained by means of a dilute solution of copper containing 0·04 grm. copper per 10 c.c. The result shows the excess of copper in the solution. On deducting it from the 0·5 grm. of copper employed we obtained the weight of the copper precipitated by the zinc, and on multiplying this by the coefficient 1·0236 we obtain the quantity of metallic zinc contained in the 0·4 grm. of zinc powder.

Battery with Carbon-Electrodes without Metals.—D. Tommasi and Radignet.—This paper requires the accompanying figures.

Action of Ethylic Aldehyd upon Resorcine.—H. Causse.—The product obtained is a yellow crystalline body of the composition $C_{14}H_{14}O_4$, which answers to 1 mol. of aldehyd and 2 mols. resorcine less 1 mol. of water.

On the Nitro-sulphuretted Saccharine of Fahlberg.—E. Maumené.—The compound produced according to the method patented by Fahlberg is not a definite chemical compound, but a mixture of at least two principles.

Determination of Total Nitrogen in Organic Matters.—M. Raulin.—(See Chemical News, vol. lv., p. 147).

Novel Process for the Determination of Tannin.—M. Villon.—This memoir will be inserted at length.

Regeneration of the Residuary Acid from the Manufacture of Gun-Cotton.—E. Allary.—The author filters the acids over quartz sand and distils.

Journal für Praktische Chemie.
New Series, Vol. xxxv., Parts 1 and 2.

Determination of Fatty Acids in Soaps.—Prof. Dr. Bauer.—The author selects two watch-glasses, a larger and a smaller, puts in the larger a thin layer of small glass beads, upon which the smaller watch-glass is set as if in a sand-bath. The whole is weighed together and serves for the reception of the fatty acid. The solution and decomposition are effected in the usual manner, *i.e.*, 5 grms. of fresh (not dried) borings of the soap are placed in a small long-necked boiling flask, holding about 150 c.c., and covered first with concentrated glycerin and heated until the soap is uniformly subdivided. About 100 c.c. of alcohol are then added, and the clear liquid is titrated with hydrochloric acid. After the alkali has thus been determined an excess of acid is added, and the fat, which after some time separates out quite clear and accumulates in the neck of the flask, is removed by means of a pipette provided with a fine point and a caoutchouc pipe and put in the upper of the two watch-glasses which have been heated in the air-bath. The fatty acid adhering to the flask is then washed out by pouring in 2 c.c. of petroleum ether or benzine, shaking well, and adding the solution to the matter in the watch-glass until the weight of these glasses remains constant.

A Convenient Method of Preparing the Bromised Fatty Acids.—A. Michael.—The author heats the chloride of a monobasic fatty acid with rather more than the calculated quantity of bromine (in order to form the monobromo-derivative) and a rather large quantity of carbon disulphide in a flask provided with a reflux condenser until the escape of hydrobromic acid ceases. To obtain the acid the chloride is introduced into water and fractionated, whilst the corresponding ether is prepared by introduction into absolute alcohol, precipitation by water, and fractionation. The bromine must have been carefully dried.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Analysis of Alum Cake.—We should be glad to be referred to the most accurate method of analysis of "Alum Cake," made from China clay, for alumina and free sulphuric acid most particularly. Can you tell us any really good and reliable work treating on this subject fully, also on the analysis of China clays? For this information we shall feel most obliged.—C. N. and Co.

MEETINGS FOR THE WEEK.

Monday, 11th.—Medical, 8.30.
Tuesday, 12th.—Royal Medical and Chirurgical, 8.
—— Photographic, 8.
Wednesday, 13th.—Microscopical, 8.
—— Pharmaceutical, 8.
Thursday, 14th.—Telegraph Engineers, 8.

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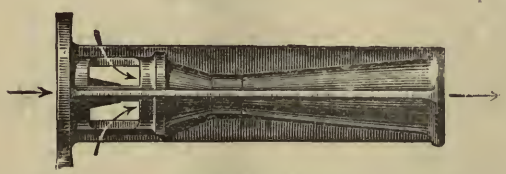

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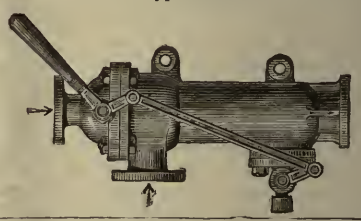

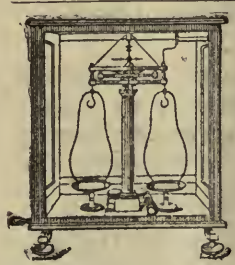

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THE CHEMICAL NEWS.

Vol. LV. No. 1429.

NOTE ON THE DEVELOPMENT OF VOLTAIC ELECTRICITY BY ATMOSPHERIC OXIDATION.*

By C. R. ALDER WRIGHT, D.Sc., F.R.S.,
Lecturer on Chemistry and Physics,
and C. THOMPSON, F.C.S.,
Demonstrator of Chemistry, in St. Mary's Hospital Medical School.

It is well known that when metallic copper is brought into contact simultaneously with atmospheric air and aqueous solution of ammonia, rapid oxidation is set up, the copper oxide formed dissolving in the liquid, producing a *blue* solution of ammoniacal cupric oxide, or cuprammonium hydroxide. Whilst investigating processes for the manufacture of this fluid (now used commercially on a considerable scale) we noticed that if the air supply be greatly in deficiency relatively to the bulk of the copper, under certain conditions the solution is but little coloured, containing copper dissolved principally as cuprous, and not as cupric, oxide. This might, perhaps, be anticipated *à priori*, inasmuch as it is well known that blue cupric solution in ammonia, when digested with metallic copper in the absence of air, takes up a second equivalent of copper, becoming colourless cuprous solution; but further experiments seem to indicate that the production of cuprous oxide under the oxidising influence of a limited supply of air is the primary action, and not merely a secondary result; in short, that the first step in the change is expressed by the reaction $4Cu+O_2 = 2Cu_2O$; cuprous oxide being formed, which then (under favourable conditions) becomes further oxidised to cupric oxide, thus—

$$2Cu_2O+O_2 = 4CuO,$$

and not by the reaction $2Cu+O_2=2CuO$; the cupric oxide thus formed as the first product becoming subsequently reduced (in the absence of air) to cuprous oxide, thus—

$$CuO+Cu = Cu_2O.$$

When a sheet of copper is kept out of direct contact with air by being immersed in ammonia solution, oxidation of the metal is gradually effected by virtue of the dissolving of oxygen from the air at the surface of the fluid, and diffusion of the oxygen solution to the vicinity of the copper. This action is an extremely slow one if the copper be covered by some depth of fluid, and if the setting up of convection currents through heating or evaporation be prevented by keeping the vessel perfectly at rest and at an equable temperature, and well closed to prevent escape of ammonia; but if these precautions be neglected it goes on much more rapidly, and the liquid comparatively soon becomes blue; it can, however, be also materially accelerated by arranging horizontally on the surface of the fluid a plate of platinum or other electrically conducting material not chemically acted upon by the fluid, and connecting this by means of a wire, &c., with the copper plate. The upper conductor, or *aëration plate* as it may be conveniently termed, being simultaneously in contact with the atmosphere and fluid, attracts to its surface a film or aura of condensed gases, the oxygen of which becomes gradually transferred to the copper, a voltaic current circulating through the fluid and connecting wire. Cuprous, and not cupric, oxide thus results, dissolved in the ammonia solution in contact with the copper plate, the mechanism of the reaction being conveniently represented by the scheme—

$$\begin{cases} \text{Copper plate} & Cu_2 \mid OH_2 \mid OH_2 \mid O & \text{Aëration plate,} \\ \text{Copper plate} & \mid Cu_2O \mid H_2O \mid H_2O \mid & \text{Aëration plate,} \end{cases}$$

water being represented as the electrolyte for simplicity's sake. The air film on the aëration plate being constantly renewed by absorption from the atmosphere, the process goes on continuously as long as the two plates are connected together by the wire. This wire may be lengthened at will so as to make the current which passes through it whilst the action goes on relatively stronger or weaker according to the amount of resistance introduced into the circuit; and by including a galvanometer or silver voltameter in the circuit the ordinary phenomena due to the passage of currents are readily recognisable.

A voltaic cell thus produced "runs down" very rapidly when the resistance in circuit is diminished, more or less recovering when the resistance is again increased; with a large resistance (*e.g.*, sufficient to reduce the current density to a micro-ampère or less per square centimetre of aëration plate surface), a very notable E.M.F. is maintained, amounting under favourable conditions to 0·5 or 0·6 volt. The maximum E.M.F. thus capable of development varies considerably with the strength of the ammoniacal solution, being the less the weaker the fluid; addition of common salt or of sal-ammoniac to the liquid notably increases the E.M.F. and diminishes the internal resistance of the cell. Spongy platinum in a thin layer as the aëration plate gives higher values than thin platinum foil; the highest numbers thus obtained, using pretty concentrated ammoniacal brine, fell but little short of 0·8 volt; or somewhat less than the E.M.F. corresponding with the heat of formation of cupous oxide,* since, according to Julius Thomsen, $Cu_2O = 40810$ = about 0·88 volt.

It is obvious that this copper atmospheric oxidation cell has a close connexion with the "air-battery" described in 1873 by Gladstone and Tribe (*Roy. Soc. Proc.*, vol. 21, p. 247), in which what is virtually an "aëration plate," consisting of a tray full of crystals of silver, is used, opposed to a copper plate immersed in a solution of copper nitrate. Cuprous oxide is formed in both cases, in virtue of the indirect combination brought about between the oxygen of the air and the copper: but there is this great difference between the two (apart from the cuprous oxide being deposited as such in Gladstone and Tribe's arrangement, and being kept in solution in ours), that in the one the cuprous oxide is formed *at the surface of the copper plate* itself, and in the other *at the surface of the aëration plate*. This essential difference is embodied in the above depicted scheme as compared with the following one which represents the action in Gladstone and Tribe's cell:—

$$\begin{cases} \text{Silver} + O & \left| \begin{matrix} Cu(NO_3)_2 \\ Cu(NO_3)_2 \end{matrix} \right| \begin{matrix} Cu(NO_3)_2 \\ Cu(NO_3)_2 \end{matrix} \left| \begin{matrix} Cu \\ Cu \end{matrix} \right\} \text{Copper.} \\ \text{Silver} \left| O \left\{ \begin{matrix} Cu \\ Cu \end{matrix} \right| \begin{matrix} (NO_3)_2Cu \\ (NO_3)_2Cu \end{matrix} \right| \begin{matrix} (NO_3)_2Cu \\ (NO_3)_2Cu \end{matrix} \left| \text{Copper.} \right. \end{cases}$$

One result of this difference is that the surface of the aëration plate in the ammonia cell is kept constantly the same, whereas in the nitrate cell it is continually changing its character through deposition of solid cuprous oxide on the silver: in consequence of this deposition, whilst the E.M.F. of the ammonia cell, *cæteris paribus*, is constant, that of the nitrate cell is continually varying. Gladstone and Tribe, moreover, only obtained an E.M.F. of $\frac{1}{5}$ to $\frac{1}{4}$ of a Daniell, or about 0·104 to 0·143 volt, even under the most favourable conditions, viz., when the cell was connected with an electrometer; whilst four or five times this amount is indicated by the cells examined by us.

In order to examine separately the fluids collecting round the two plates after action had gone on for some time, we employed cells of U-shape; and to obtain as large an aëration surface as possible we adapted to one

* A Paper read before the Royal Society, March 31, 1887.

* The actual chemical change going on in the cell is the synthesis of cuprosoammonium hydroxide, so that the (unknown) heat of solution of cuprous oxide in ammonia should be added to this to obtain the total heat development.

leg of the U a funnel (as indicated in the figure) with the stem cut off, and united to the U-tube by a piece of india-rubber tubing, *a*, slipped tightly over the junction. The other end of the U-tube was closed with an india-rubber cork, *b*, through which passed a piece of glass tubing with a platinum wire, *c*, sealed into it at the lower end and filled with mercury, thus forming a mercury cup, and serving to make contact with the copper plate, *d*, which was soldered to the end of the platinum wire, the soldering and platinum being coated with gutta-percha, so that only the copper plate was in contact with the fluid with which the U-tube was subsequently filled. A similar glass tube and platinum wire mercury cup, *f*, served to make contact with the aëration plate, which was conveniently supported horizontally at the surface of the fluid in the funnel by means of a disk of porous earthenware, *e*; by fixing a rim of gutta-percha round this disk so as to convert it into a sort of tray like the lid of a pill-box, and filling this tray with platinum sponge, an aëration plate of spongy metal was readily obtained. By interposing suitable resistances, galvanometer, silver voltameter, &c., in the external circuit obtained on connecting the two mercury cups by a wire, the current passing could be modified at will, and shown to exhibit all the ordinary phenomena of moderately weak currents.

After continued action with small resistance only in circuit, the liquid in the funnel was found on analysis to contain no copper whatever; whilst that surrounding the copper plate, though colourless before removal from the tube, speedily became blue on exposure to air, and contained more or less considerable amounts of copper in solution, obviously originally in the condition of *cuprous* oxide, Cu_2O.

Following up the ideas suggested by the above observations, we are making a number of experiments with a variety of analogous combinations, in which atmospheric oxidation constitutes the essential chemical action taking place; by varying the nature of the aëration plates, the metals dissolved, and the liquids employed (as also by substituting other gases, *e.g.*, chlorine, for air), a large number of combinations are obviously obtainable. Some of those which we have so far examined present points of considerable interest, the oxidising action exerted under favourable conditions being strongly marked: so much so that certain metals, *e.g.*, mercury and silver, not ordinarily prone to atmospheric oxidation, can under suitable conditions be gradually oxidised and dissolved in appropriate liquids, just as the copper is dissolved in the ammonia in the cell above described; these actions, moreover, being accompanied by the development of currents of strength sufficient to cause measurable amounts of electrolytic decomposition outside the cell, *e.g.*, in a silver voltameter.

NEW PROCESS FOR THE DETERMINATION OF TANNIN.

By M. VILLON.

The determination of tannin presents difficulties: on the one hand, the same process gives different results if applied to extracts of different origin containing the same quantity of tannin, and, on the other, different methods applied to the same extract give different results.

The matter which it is important to determine in practice is the *tannin assimilable in the cold*,—that is, a substance which precipitates albumen and gelatin, which gives coloured precipitates with metallic salts, and which has the property of being absorbed usefully by hides to form leather.

There exist, in extracts along with tannin, allied substances which possess more or less the other properties of tannin, but which want this characteristic—such as gallic, ellagic, glauco-melonic, and gallamic acids, and even a modification of tannin which is produced in presence of gallic acid. Certain methods which do not depend upon the use of hide may determine these substances more or less, and falsify the indications. Even the use of the hide may produce inconvenience, either by giving up to the solution certain principles or by absorbing substances other than the assimilable tannin.

Among the thirty-two known methods for determining tannin that of Hammer, by the difference of the specific gravity of the solution before and after treatment with hide; the method of Müntz, which is merely a modification of the former; and that of Löwenthal, with permanganate, are the only ones which give satisfactory results. The author, instead of hide, uses a solution of lead acetate, suitably diluted, the use of which is more expeditious than that of hide: this process depends on the fact that lead acetate precipitates tannin, and not gallic acid and its allies.

Liebig and Strecker first remarked that a solution of lead acetate gives a yellow precipitate with tannic acid. Stein, in 1857, devised a method for determining tannin by precipitation with a boiling solution of lead acetate in excess. The precipitate was collected and ignited, and the lead oxide weighed, which formed 64 per cent, whence the tannin was readily calculated.

The author finds that the precipitate of lead tannate varies in its composition according to the temperature and the concentration of the solutions. He finds, however, that in a liquid containing a weight of lead acetate equal to three to five times that of the tannin, the precipitate formed has a constant composition. The addition of a small quantity of sodium acetate promotes the formation of the precipitate, which is of a constant composition and is not dissociated by water. Upon these facts he founds the following process:—

Prepare the tannin liquor so that 100 c.c. may contain about 2 grms. of tannin. Prepare a lead liquor by dissolving in heat 100 grms. neutral lead acetate and 20 grms. sodium acetate in 500 grms. water, and making up the solution to exactly 1 litre. Mix in a precipitating glass 100 c.c. of the tannin liquid, 100 c.c. of the lead solution, leave them in contact for five minutes, and filter. Take the sp. gr. D of the lead acetate, the sp. gr. D′ of the tannin liquor, and the sp. gr. δ of the filtered mixture, all at the same temperature. The proportion of tannin in the liquid under examination is then calculated as follows:—If the two liquids mixed without precipitation or alteration in volume the sp. gr. of the mixture would be—

$$\frac{D+D'}{2};$$

but as the lead tannate disappears from the liquid the sp. gr. is diminished, and we find a difference—

$$\frac{D+D'}{2}-\delta.$$

Let Σ be the difference of sp. gr. produced in an aqueous solution, of a volume equal to 100 c.c. by the disappearance of the same weight of tannin as that precipitated as lead tannate; probably—

$$\frac{D+D'}{2}-\delta$$

will be proportional to Σ, whence—

$$\left(\frac{D+D'}{2}-\delta\right)A=\Sigma.$$

This equation permits us to calculate Σ, if A is determined once for all, and from Σ to deduce p, the weight of tannin in grammes contained in 100 c.c. of the solution in question, by means of Hammer's table. This table may be summed up in the following formula:—

$$p=\frac{\Sigma}{0{\cdot}00405}.$$

The constant A is not the same for all the tannins: for gallotannic acid it is 50 per cent; for quercitannic acid, 45·3; castaneotannic, 44·8; aspidospertannic, 42·5; abietannic, 40; and catechutannic, 52 per cent.—*Bulletin de la Soc. Chimique de Paris* (vol. xlvii., p. 97).

ON THE SOLUBILITY OF LITHIUM CARBONATE.

By CARTER NAPIER DRAPER.

Among the few chemists who state it with any approach to precision there is remarkable unanimity as to the solubility of lithium carbonate at ordinary temperatures. Gmelin (citing Vauquelin), Watts, and Fehling concur in giving it as 1 part in 100. Kremer* differs from these authorities, and gives the solubility as 1 in 130 water at 13°. At higher temperatures the solubility is given by—

Kremer, as *less soluble* in hot than in cold water (1 in 128·5 at 100°).
Fehling, as *equally soluble* in hot and cold water.
Vauquelin, as *more soluble* in hot than in cold water.

In presence of these statements, nearly concurrent as regards the cold water solubility and strikingly discrepant as to the solubility in hot water, a re-examination of the facts seemed desirable, and this was undertaken, with the results now to be detailed.

The lithium carbonate employed was prepared in the following way:—The commercial carbonate was dissolved in hydrochloric acid, and the slightly acid solution having—by testing a portion with hydrogen sulphide, and with ammonia and ammonium sulphide—been found to be uncontaminated by the presence of the heavy metals, the remainder was freed from traces of iron, calcium, and magnesium, by successive treatment with ammonia, ammonium carbonate, and lithium hydrate. The solution was then concentrated by evaporation, and the lithium precipitated as carbonate by ammonium carbonate. The precipitate having been washed, first with water and then with alcohol (methylated spirit of sp. gr. 0·830), until the filtrate gave no indication of chlorine, was dried at 100°.† Of this carbonate two distinct solutions were obtained by frequent agitation with distilled water at 15°, during twelve hours. From each of these, two portions of 10 c.c. were measured. On evaporating in platinum, and drying the residue at 100°, the following results were obtained:—

Solution I.

a. 10 c.c. gave 0·1475 grm. *b*. 10 c.c. gave 0·1475 grm.

Solution II.

a. 10 c.c. gave 0·1485 grm. *b*. 10 c.c. gave 0·1480 grm.

Giving the solubility of lithium carbonate in water at 15° as 1·4787 per cent.

To determine the solubility at 100°, excess of the carbonate was boiled with distilled water for fifteen minutes, and the solution filtered while hot. About 10 c.c. of the first passing filtrate were rejected, and the quantity to be used having been received in a graduated cylinder provided with a stopper, was allowed to cool, and its volume noted. It was then transferred to a platinum dish, and the cylinder rinsed with distilled water, which was added to the solution. This was then evaporated on a water-bath, and the residue dried at 100° and weighed with the usual precautions. Four experiments gave the following results:—

28	c.c. gave	0·1965	grm. carbonate, or	0·701	per cent.
32	,,	0·2350	,,	0·734	,,
50	,,	0·3580	,,	0·716	,,
42	,,	0·3000	,,	0·714	,,

indicating a mean solubility at 100° of 0·7162 per cent.

The solubility of lithium carbonate at ordinary temperatures is therefore nearly 50 per cent greater than that stated by the authorities above cited; and water at 100° dissolves rather less than one-half the quantity which it is capable of dissolving at 15°.

Dublin, March, 1887.

* *Jahresbericht der Chemie* (quoted by Watts, vol. i., p, 787).

† Operating upon 250 grms. of commercial lithium carbonate, the product obtained was, owing to the solubility of the precipitate in ammonium carbonate, disappointingly small; and even this, to free it from chloride, required no less than *ten litres* of methylated spirit!

ON THE PHYSICAL PROPERTIES OF MANGANESE STEEL.*

By W. F. BARRETT,

Professor of Experimental Physics in the Royal College of Science for Ireland.

(Concluded from p. 159).

Breaking Stress.—Experiments in the breaking stress of the wire were now made. The dynamometer I used was tested and found correct. A comparative experiment was made with pianoforte steel wire, 0·027 inch diameter. This broke at a stress of 150 lbs., corresponding to a breaking stress of 117 tons per square inch. Ordinary steel wire has a breaking stress of 54 to 63 tons per square inch. The tenacity of the best pianoforte steel wire is the highest known, and amounts to 150 tons per square inch.

The *soft manganese steel wire*, No, 19 S.W.G., or 0·96 millimetres in diameter (that is an area of 0·00125 square inch), broke at a stress of 124 lbs., with 18 per cent elongation; the elongation, in fact, was remarkable, being 4 centimetres in 22 centimetres. This breaking stress is equivalent to 48·8 tons per square inch.

The *hard wire* of the same size had a far higher tenacity and far less elongation. The first experiment gave a breaking stress of 280 lbs., or one-eighth of a ton, which corresponds to the enormous *breaking stress of* 110·2 *tons per square inch.* A second experiment gave a breaking stress of 278 lbs., which corresponds to 109·4 tons per square inch, with an elongation of but little over 1 per cent; the ordinary steel wire I tried elongated double this amount. Experiments on the breaking strain of bars of this steel have also been made by Mr. Barnaby, the Admiralty Inspector in Sheffield, who found that the specimen of manganese steel he tried bore a strain of 67 tons per square inch, with the extraordinary amount of 44 per cent elongation before breaking.

High as is this figure, the number I obtained for the wire was far higher, and in fact was so remarkably high that I was anxious for an independent determination with another dynamometer. Mr. H. A. Ivatt, the Locomotive Engineer of the Great Southern and Western Railway Works at Inchicore, kindly undertook this for me, as in their works a new and very accurate dynamometer has recently been erected. Mr. Ivatt found my figure was perfectly correct, and sends me the following statement:—

(See next page).

Mr. Ivatt also tried a specimen of thicker wire, No. 13 gauge; but I had previously spoilt this specimen by testing the effect of heating it to whiteness and quenching in cold water, which rendered the wire soft. This specimen in its soft state, Mr. Ivatt found, had a breaking stress of 47·4 tons per square inch, nearly the same as I found for the fine wire in the soft state. Mr. Ivatt tried to harden it, and writes:—"Heating the No. 13 wire to redness, and allowing it to cool very slowly, is, I find, the only way to harden it." This rendered the wire hard and brittle, and

* A Paper read before the Royal Dublin Society, December 15, 1886.

G. S. & W. R.—Locomotive Department, Inchicore Works, Dublin.

Expt.	Date.	Description of material, &c.	Standard wire guage.	Area, sq. inches.	Tensile stress. Total lbs.	Tensile stress. Tons per sq. in.	Appearance of fracture.	
1.	Dec. 13.	Manganese steel wire, from Prof. Barrett.	No. 19	0·00125	291	103·8	Hard and brittle.	
2.	,,	,, ,,	,,	,,	310	110·7	,,	,,
3.	,,	,, ,,	,,	,,	302	107·9	,,	,,

Owing to the extremely brittle nature of the metal, the elongation could not be detected.

(Signed), H. A. Ivatt, Locomotive Engineer.

Tested by W. C. Irwin.

apparently lessened its tenacity, for the same wire now broke at a stress of 38·3 tons per square inch.

It will be interesting to compare the tenacity of the manganese steel wire, in grammes per square centimetre, with that of iron and steel. According to Sir W. Thomson (Art. "Elasticity," *Encyc. Brit.*, new edit.), the tenacity or breaking stress of—

	Grms. per square c.m.
Iron wire is	625 to 651 × 10⁴
Steel wire	859 to 991 × 10⁴
Best pianoforte steel wire	2362 × 10⁴
Common pianoforte steel wire	1851 × 10⁴
Hard manganese steel wire..	1735 × 10⁴

The two last are my own determinations.

Electric Resistance.—I next determined the *electric conductivity* of the wire. For this I employed No. 19 wire, 0·96 m.m. dia., in a length of 510 c.m. This had a resistance of 5·22 ohms, *i.e.*, practically an ohm per metre. The resistance of the hard and soft wire were exactly alike. The specific resistance was 0·000077 of an ohm, or 77,000 C.G.S. units for a cubic centimetre. This is very high: the sp. resistance of ordinary iron is 9827 C.G.S., and of German silver wire 21,170 C.G.S. units per centimetre cube. Experiments are in progress to determine how far its resistance is affected by change of temperature; but, in any case, the remarkably high resistance of manganese steel wire points to a useful application of this material for the construction of resistance coils for electric lighting and other purposes.

I now come to the next and most interesting feature of this steel—its magnetic inertness.

Magnetic Coefficients.—Mr. Bottomley, in his note before the British Association to which I have referred, stated that he had submitted the bar of manganese steel to an enormous magnetising force (far beyond what would be necessary to saturate ordinary steel), and after the magnetisation of the manganese steel he had determined its intensity of magnetisation, by the deflection of a mirror magnetometer. The number so obtained showed a magnetic moment $\mu = 2{\cdot}55$ C.G.S. units. Dividing this by the weight of the steel we obtain the magnetisation per gramme, which is 0·013 C.G.S. units. Ordinary steel has a number ranging from 40 to 60, and even up to 100, C.G.S. units per gramme.

Hence the ratio of the intensity of magnetisation in manganese steel to that in ordinary steel is as 1 to 3000, up to 1 to 7700 in the best qualities.

So that the intensity of magnetisation that can be given to manganese steel is, say, 5000 times less than that given to steel of average quality; or if steel be 100,000, manganese steel is 20.

This refers to the degree of permanent magnetism that can be imparted. It is important to know the coefficient, of *induced* magnetism of this remarkable body. This coefficient, designated by K, is the ratio of the intensity of induced magnetisation to the magnetising force of the field, or $K = \frac{i}{H}$: this is now generally termed the *magnetic susceptibility* of the substance.

The experimental determination of this constant, for so feeble a magnetic body as manganese steel, proved a more difficult task than I anticipated, as it is scarcely comparable with iron, and therefore like weighing stones and grains on the same balance.

I first tried the method of torsion adopted by Faraday in the determination of the magnetic force of magne-crystallic bodies, and described by him in the last of his "Experimental Researches in Electricity," *Phil. Trans.*, 1855.

A platinum wire, hung from a graduated torsion head, suspended the specimen under examination in a powerful and uniform magnetic field obtained from a large electro-magnet. A graduated circle was placed below the object under trial, the zero coinciding with the axial position of the object. On exciting the magnet, and then turning the torsion head, the object was twisted out of its axial position, and at last reached a position of unstable equilibrium, when it suddenly swung round to the axial position again, but with reversed ends. The degree of torsion required, *minus* the upsetting angle, was used by Faraday to "measure the force which solicits the body to retain its axial position," that is to say, it is a relative measure of the magnetism induced in the body, or its susceptibility.

A single example out of many experiments will show the working of this method. A piece of manganese steel wire 2·15 millimetres diameter and 44 centimetres long, was suspended (by a platinum wire attached to a torsion head) in a uniform and constant magnetic field. On turning the torsion head, the upsetting angle was found to be 60°, and the torsion required for this was 158°. Hence 158° − 60°, or 98°, is the actual force of torsion employed. With a piece of fine iron wire of precisely the same length and 0·2 millimetre diameter, the upsetting angle was 70°, and the torsion required 320°. Hence 320° − 70°, or 250°, was the force required in this case. The ratio of the forces of the two bodies are therefore as 1 : 2·5. The ratio of the volumes of the two substances will be as the squares of their diameters, or as 1 : 115. Assuming the magnetic moment increases as the volume of the bodies, the ratio of the forces multiplied by the ratio of the volumes will express the ratio at the susceptibilities of the two bodies, which gives

1 : 287.

There are, however, some objections to this method of experiment, as the upsetting angle is not the same, and hence the magnetic distribution at two different angles will not be alike in the two cases.

The following method is free from this objection. The force required to turn each of the two substances through a given very *small* angle, when they are suspended in a magnetic field of constant strength, is found: this value (less the angle of deviation), multiplied by the ratio of the volumes of the two bodies, will give the number sought. A mirror was attached to the cradle supporting the body, and by means of a lamp and scale, a very accurate measure of the angle through which the substance was turned could be obtained. A constant current of 7½ amperes was used to magnetise the electro-magnet, a uniform field being obtained between two large upright pole pieces. The torsion required to turn the manganese steel through 18° was in one experiment 42·5°, and in another 42·3°, or a mean of 42·4°. The torsion required to turn the fine iron wire through the same angle was 94°. This, less the angle of deviation, gives a ratio of 1 : 3. In a more powerful field the numbers

were 66° and 68°, or a mean of 67° for the manganese, and 155·5° and 156·5°, or a mean of 156° for the iron, a ratio of 1 : 2·8. The volumes of the bodies being as 1 : 115, the former experiment gives a ratio of the susceptibilities as 1 : 345 and the latter as 1 : 322. *Hence we may say that the manganese steel has about* 330 *times less magnetic susceptibility than soft iron;* or, if iron be 100,000, manganese steel will be about 300—a very different number, it will be observed, from that obtained by Mr. Bottomley, for the intensity of permanent magnetisation of the two bodies.

A few experiments were now made to determine whether this method showed that the magnetic moment was directly proportional to the volume of the material. Half-a-dozen pieces of fine manganese steel wire were cut, of equal lengths, and the upsetting force and corresponding angle determined in each case. The angle being 60°, the upsetting forces, less this angle, were as follows:—

	Upsetting Force.	Force per piece.
With 1 piece	132	132
,, 2 pieces	236	118
,, 3 ,, ...	400	133
,, 4 ,, ...	538	134
,, 5 ,, ...	664	133
,, 6 ,, ...	793	132

Dividing the upsetting force by the number of pieces in each case, we obtain the force per piece, as shown in the last column. With the exception of the second experiment—which is evidently erroneous—it will be seen that the forces are directly proportional to the number of pieces, and hence to the volume of the body.

Since I began this investigation, Dr. J. Hopkinson has sent me his paper on the "Magnetisation of Iron," read before the Royal Society of London, in April, 1885. Until I received this paper I was unaware that Dr. Hopkinson had been experimenting on the magnetic properties of manganese steel. The method adopted by Dr. Hopkinson to determine the magnetic susceptibility was wholly different from that which I employed, and consisted in measuring the induced current generated by the sudden removal of a small coil of wire that encircled the iron or steel bar under experiment, and which bar had previously been submitted to a powerful magnetising current. The maximum magnetisation of wrought-iron and of manganese steel (with 12·36 per cent of manganese) deduced from Dr. Hopkinson's figures are as 1441 to 5·6, or 258 to 1.

These numbers are fairly in accordance with those I have obtained, viz. 330 to 1, for steel containing 13·75 per cent of manganese. Considering the wide range of the figures in the table given by Dr. Hopkinson, I should imagine that his ratio is somewhat less reliable than the one I have given.

Other Magnetic Properties.—It was interesting to ascertain whether the presence of this percentage of manganese in steel deprived it of other well-known magnetic properties. As might be expected, it showed no elongation under magnetisation. It did not exhibit the magnetic tick or sound heard when iron, steel, nickel, or cobalt is magnetised and demagnetised. A more interesting question was whether it would exhibit the anomalous expansion and after-glow which take place in iron or steel wire when they cool to a certain critical temperature, after being heated to whiteness. I have shown that these phenomena are coincident with that temperature when the magnetic state of these metals, destroyed by a high temperature, is resumed on cooling. Careful experiments with the manganese steel wire, heated to a bright whiteness, established the fact that no trace of this anomalous deportment on cooling occurred with this substance. Here then we have a singular and an important link between the magnetic state of a body and its sudden and momentary expansion and reheating, when at the critical temperature. Like manganese steel, the non-magnetic metals—platinum, copper, German silver, silver and gold wire—do not exhibit this phenomenon.*

I have good hope that the experiments here recorded will become a starting-point for further investigation. When we remember that 13 per cent of a non-magnetic metal, *mechanically mixed* with iron or steel, produces but a slight change in the magnetic state of the latter, and then consider the profound magnetic change brought about by 13 per cent of manganese (itself a feebly magnetic metal) when *alloyed* with steel, we are led into speculation as to the nature of magnetism, and why chemical union should destroy the magnetic state. Manganese steel has about the same magnetic susceptibility as ferric oxide; German silver, in like manner, which is an alloy of brass with the magnetic metal nickel, is itself magnetically inert. Why is this? Do the molecules of manganese insulate the imaginary Amperian currents in the iron, and so prevent the molecular movement which invariably accompanies the act of magnetisation? But if so, how? The electric resistance of manganese steel, as a whole, is scarcely 8 times less than iron, but the magnetic power is upwards of 300 times less.

These experiments have also a practical as well as a theoretic interest. From its high tenacity and negative magnetic properties, manganese steel is eminently adapted for the construction of those parts of machines where the magnetic properties of iron or steel are a serious disadvantage—such, for example, as the bed-plates of dynamos.

Moreover, as everyone knows that the deviation of the compass on iron ships is a grave danger in navigation, more especially from the fluctuating character of the subpermanent magnetism due to the hard iron and steel, the use of manganese steel for the construction of iron vessels and of ironclads in the navy, and for the anchors and chain cables of all vessels, suggests a simple mode of returning to the magnetic safety of our wooden vessels without sacrificing the advantages of iron.†—*Scientific Proceedings of the Royal Dublin Society.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Annual General Meeting, March 30th, 1887.

Dr. Hugo Müller, F.R.S., President, in the Chair.

The President delivered an address, of which the following is an abstract:—

The number of Fellows of the Society is 1508, of whom 30 are honorary foreign members. One foreign member, Professor A. Butlerow, has died during the year; and the Society has lost 12 Fellows by death:—Robert Alexander; Dr. James Apjohn, F.R.S.; Prof. F. S. Barff; Richard Cowper; M. G. Crossmann; H. Sugden Evans; Rev. W. Flett; George Hirst; Dr. A. P. Price; J. A. Phillips, F.R.S.; E. R. Southby; and H. H. Watson.

20 Fellows have withdrawn:—W. E. Benton; T. F. Best; L. M. Deane; A. F. Dimmock; H. W. Field; W. J. Fuller; A. E. Garrod; Norman Graham; Thos. Harrison; Thos. Jamieson; Herbert Jones; Paul Mathews; P. B. Mills; J. D. McCarthy; Dr. A. P. Page; Dr. Robert Smith; G. Tunbridge; James Steel; A. H. Scott White; Philip Wright; and Wm. Cort Wright.

* Nickel, I find, does not exhibit it, contrary to my expectation; but the magnetic state of nickel is lost at a temperature of 330° to 340° C., which is considerably below red heat. Cobalt wire I have not yet been able to obtain.

† When the foregoing Paper was read, Mr. Fletcher Moore, of Kilbride Manor, called attention to the fact that a manganese iron ore mine existed at Kilbride, Co. Wicklow, and stated that from this ore iron had been smelted of great tenacity and high quality.

28 Fellows have been removed on account of arrears:—F. H. T. Allan; P. S. Brown; Robert Blair; Henry Child; G. Crampton; John Dale; Dr. Arthur Gamgee; A. M. Graham; G. Jarmain; R. H. Jude; F. Jordan; Wm. Marriott; J. E. Mayall; J. D. Mucklow; Dr. C. S. Marsden; John McCarthy; A. A. Nesbit; F. J. O'Farrell; Alfred Payne; A. W. Postans; J. E. H. Richardson; F. I. Scard; J. Steiner; K. Takemura; G. Valentine; Stephen Williams; and James Wilson.

110 new Fellows have been elected during the year.

The number of papers communicated to the Society since the last anniversary meeting is the largest on record, being 118, or 5 in excess of the number read in 1880-81, and 14 in excess of the number read last year. The President expresses the opinion that the Society has every reason to be satisfied with the share which it has contributed to the general progress of chemical science, adding that as we contemplate the ceaseless activity in chemical research now manifested all over the world, and which from year to year is continually on the increase, we are, nevertheless, bound to recognise the fact that vast as the work thus accumulated may appear, there remains still much to be accomplished. The more the field is worked the richer will be the harvest.

The numbers of Abstracts and Papers published in the *Journal* during the past five years are given in the following table:—

	1881.	1882.	1883.	1885.	1886
General and Physical Chemistry	219	205	237	331	235
Inorganic Chemistry ..	188	189	189	191	223
Mineralogical Chemistry	135	204	192	201	223
Organic Chemistry . ..	837	739	939	1047	1056
Physiological Chemistry	112	73	118	142	100
Chemistry of Vegetable Physiology and Agriculture	270	163	324	218	160
Analytical Chemistry ..	284	195	256	337	289
Technical Chemistry ..	228	212	286	280	66
Total	2273	1980	2541	2747	2352
Papers in Transactions..	65.	63.	57.	85.	85.

After dwelling on the importance of the determination of physical properties, the President gave a brief review of the more noteworthy chemical investigations of the year; and reference was then made to the work of the City and Guilds of London Institute for the advancement of technical education, with which the President of the Chemical Society is *ex officio* associated. Dr. Müller concluded his address with the following statement:—

The mistaken notion is still too prevalent that technical education has to confine itself to the theoretical considertions of known technical processes, and that a more extended acquisition of scientiffc knowledge is not required, It is obvious that a pupil educated on these lines may find by the time he is able to enter on his practical career that the processes with which he has been made acquainted have in the meanwhile become obsolete, and unless his education has been sufficiently comprehensive to enable him to strike out new lines for himself, he will be ill fitted to compete with those who have been educated on a wider basis.

Essential as it is to impart scientific knowledge to the future manager, it is above all necessary to train him by practical work and research in the laboratory how to investigate a subject which may present itself in his daily occupation, whether it be some unexpected development in a new direction, or whether it be some new difficulty which confronts him in carrying out the processes under his direction. It is self-evident that such knowledge and such practical experience in carrying out investigations is not to be attained by merely attending one or two courses n the lecture room or in the laboratory. Those who mean o effectually qualify themselves for such functions can only accomplish this object by devoting years of patient and intelligent work under the guidance of the professor in properly appointed laboratories.

Prof. Odling proposed that the thanks of the meeting be given to the President for his address, and that he be requested to allow it to be printed. This motion was seconded by Dr. Gladstone, and accepted with acclamation by the Fellows present; the President acknowledged the compliment.

Professor Ramsay moved that thanks for their important services be given to the Editor, Sub-editor, Abstractors, and Librarian; the motion was supported by Mr. Dunstan. Mr. Groves replied.

Dr. A. K. Miller and Dr. Rideal were then appointed scrutators, and a ballot having been taken, the Officers and Council for the ensuing year were declared elected. (See p. 154).

The Treasurer, Dr. Russell, gave an account of the Society's financial condition. The receipts by admission fees and subscriptions had been £2999 2s.; by sale of Journal, £369 19s. 2d.; by dividends on invested capital, £305 0s. 9d. The expenses on account of the Journal had been £2026 16s. 9d; on account of the Abstracts of Proceedings, £163 4s. 11d.; on account of the Library, £323 11s. 10d.; on account of the Catalogue, £249; the total expenses being £3416 14s. 2d.; £500 had been invested in Metropolitan Board of Works 3½ per cent stock, and there was a balance in hand of £1301 10s. 3d.

Mr. David Howard moved that the thanks of the Society be tendered to the Treasurer for his services during the past year; Mr. Friswell seconded the motion. The Treasurer in the course of his reply took occasion to point out that the expenses connected with the issue of the circular relating to the Imperial Institute and the collection of contributions thereto would not be borne by the Society, and that his connexion with the fund was a purely private one.

Mr. J. Spiller proposed a vote of thanks to the Auditors, which was seconded by Dr. H. F. Morley, and acknowledged by Mr. Wyndham Dunstan.

A vote of thanks to the Officers, Council, and Committee, was proposed by Mr. Warington, seconded by Mr. Davies, and acknowledged by Dr. Armstrong.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, April 4th, 1887.

His Grace the Duke of Northumberland, K.G., D.C.L., LL.D., President, in the Chair.

The Managers reported that at their meeting on the 7th of March last the following letter from Dr. Tyndall to the Honorary Secretary was read:—

"Hind Head, Haslemere,
March 6th, 1887.

"My dear Sir Frederick Bramwell,

"The year's holiday so graciously and considerately granted me by the Managers will come to an end next month; and it therefore behoves me to state without further delay, for the information of the Managers, how matters stand with me.

"A brief conversation with my friend Sir Frederick Pollock, and my own reflections thereupon, have convinced me that instead of making a statement myself at the Board Meeting on Monday, it will be more expedient to embody what I have to say in a letter to you.

"For more than one-third of a century it has been my privilege to enjoy the unfailing sympathy and encouragement of the Managers and Members of the Royal Institution. It is now my duty to return to their hands the trust which they first committed to me in the spring of 1853. I have come to this resolution on account of the need I feel of thorough rest, and of freedom from engage-

ments, as to lecturing, the non-fulfilment of which would be detrimental to the Institution, and a cause of sore distress to myself.

"Worries connected with building, and other worries inimical to quietude of brain, have for the last few years troubled me much. These are now, for the most part, things of the past, so that the freedom I seek will, I doubt not, soon restore me to good health.

"I returned from Switzerland in October so refreshed and invigorated that I hoped to be able to cope successfully with all the duties then before me. I had assured myself of the friendly aid of Mr. Crookes, and had even arranged to go to Paris to purchase some instruments necessary for my contemplated work. To the end of the year my health continued strong. Then came a long-continued spell of withering easterly winds, which chilled me, dried me up, and brought on an attack of sleeplessness, intense while it lasted, but which, happily, has in great part disappeared with its cause.

"Of my ultimate and complete recovery I entertain little doubt. Still it would be obviously unfair to the Members, as it would be intolerable to myself, to allow the fortunes of our great Institution to depend in any degree upon such caprices of health. It is therefore my desire to make room for a successor whose years and vigour will place him beyond all changes and chances of this kind.

"Of the feelings called forth by my separation from the Royal Institution I have said nothing. But the Managers will understand that my silence in this respect is due, not to the absence of such feelings, but only to the conviction that on the present occasion the less said about them the better.—Believe me, most faithfully yours,

"John Tyndall."

The Managers further reported that at their adjourned meeting on the 21st of March the following Resolutions were adopted:—

Resolved, "That the Managers desire to record by this Resolution the expression of their deep regret that the state of Dr. Tyndall's health should have rendered necessary the resignation of his position of Professor of Natural Philosophy at the Royal Institution, and that it should have compelled the Managers to accept that resignation,—and desire at the same time to record the expression of their hope that the relief thus obtained from the arduous duties of the Professorship will conduce to his speedy and complete recovery.

"The Managers also desire that there should be recorded the expression of their thorough appreciation of the unremitting and most valuable services which during the long period of thirty-four years Dr. Tyndall has rendered to the Royal Institution in carrying out the duties of his office—services which not only have upheld and have advanced the position of the Royal Institution, but have benefited science and the world at large.

"The Managers having ascertained without doubt that Professor Tyndall altogether declines to receive any pension or pecuniary testimonial in recognition of his services to the Royal Institution, and that in parting from his long connection with it he desires only to carry with him the friendly recollection and goodwill of the Members,"—

Resolved, "That this generous and disinterested refusal to accept any acknowledgment of a pecuniary nature upon the occasion of his retirement cannot fail to increase the feelings of regard and respect which must be entertained for Professor Tyndall's devotion of so much of his life to the important researches which have been prosecuted by him in the laboratories of the Institution, and for the delivery of those eloquent lectures in its theatre which has done so much to support its scientific renown and to increase its prosperity. The Managers, therefore, under the before-mentioned circumstances of Dr. Tyndall's refusal to accept any pension or pecuniary testimonial, resolved that some marked recognition of a permanent character should be given to the opinion entertained of the great value of Professor Tyndall's labours now about to cease, and the Managers trust that it may prove as agreeable to him as it will be honourable to the Institution, if he would kindly comply with a request which they recommend should be made to him, to sit for his bust (in marble), to be placed in the house of the Institution in perpetual memory of his relations with it, and the cost of which should be defrayed by a vote from the general funds of the Institution; and in order further to perpetuate and honour the name of Professor Tyndall in connection with the Institution, the Managers recommend that one of the courses of Lectures delivered annually in the Institution shall be called the Tyndall Lectures."

Resolved, "That the Honorary Secretary, in informing Dr. Tyndall of the acceptance of his resignation, do send to him a copy of the foregoing Resolutions."

The Managers further reported that at their meeting held this day the following letter was read:—

"Hind Head, 3rd April, 1887.

"Dear Sir Frederick Bramwell,

"I have halted in my reply to your letter of March 23rd, through sheer inability to express the feeling which the action of the Managers, at their meeting on the 21st, has called into life.

"And my reply must now be brief; for I hardly dare trust myself to dwell upon the 'Resolutions' which you have conveyed to me. Taken in connexion with the severance of my life from the Royal Institution, and with the flood of memories liberated by the occasion, this plenteous kindness, this bounty of friendship, this reward so much in excess of my merits, well-nigh unmans me.

"And, let me add, the noble fulness of style and expression, which I owe to yourself, and in which the goodwill of the Managers takes corporate form, is in perfect harmony with the spirit which it enshrines.

"Of the Managers existent when I joined the Institution, one only remains upon the present Board. The beneficent work of many of them is for ever ended; but I do not forget the sympathy and support which they extended to me during their lives. And now the long line of kindnesses culminates in words and deeds so considerate and appreciative—so representative of their origin in true gentlemanhood, and warmth of heart, that they have almost succeeded in converting into happiness the sadness of my farewell.

"With heartfelt prayers for the long-continued honour and prosperity of the Institution which I have served so long, and loved so well, believe me, dear Sir Frederick, most faithfully yours,

"John Tyndall."

The Managers further reported that it was resolved "That having regard to the distinguished services rendered to the Royal Institution by Dr. Tyndall, he be recommended to the Members for election as Honorary Professor of Natural Philosophy."

It was then moved, and resolved unanimously, "That Dr. Tyndall be nominated for election at the next General Monthly Meeting, on Monday, May 9th, as Honorary Professor of Natural Philosophy."

Arthur Gamgee, M.D., F.R.S., Edward Bagnall Poulton, M.A., F.G.S., F.Z.S., and Miss Frances Harriet Whitehead were elected Members of the Royal Institution.

Six candidates for membership were proposed for election.

The Right Hon. Lord Rayleigh, M.A., D.C.L., F.R.S., M.R.I., was nominated for election as Professor of Natural Philosophy at the next General Monthly Meeting on May 9th.

The following arrangements for the Lectures after Easter were announced:—

John Hopkinson, M.A., D.Sc., F.R.S., B.S., M.Inst.C.E. M.R.I.—Four Lectures on "Electricity." On Tuesdays, April 19, 26, May 3, 10.

Victor Horsley, F.R.S., B.S., F.R.C.S.—Three Lectures on "The Modern Physiology of the Brain and its Relation to the Mind." On Tuesdays, May 17, 24, 31.

The Rev. J. P. Mahaffy, D.D., Professor of Ancient History in the University of Dublin.—Three Lectures on "The Hellenism of Alexander's Empire." Lecture I. on Tuesday, June 7, Macedonia and Greece; Lecture II. on Thursday, June 9, Egypt; Lecture III. on Saturday, June 11, Syria.

Prof. Dewar, M.A., F.R.S., M.R.I., Fullerian Professor of Chemistry, R.I.—Seven Lectures on "The Chemistry of the Organic World." On Thursdays, April 21, 28, May 5, 12, 19, 26, June 2.

R. von Lendenfeld, Ph.D.—Three Lectures on "Recent Scientific Researches in Australasia." On Saturdays, April 23, 30, May 7.

John W. Hales, M.A.—Four Lectures on "Victorian Literature." On Saturdays, May 14, 21, 28, June 4.

NOTICES OF BOOKS.

Record of Experiments at Fort Scott, Kansas, on the Manufacture of Sugar from Sorghum and Sugar-Cane in 1886. By HARVEY W. WILEY. Washington: Government Printing-Office. 1887.

THE results of the experiments made at Ottawa last year having given encouragement to the friends of the sorghum sugar industry, a new series of experiments was undertaken at Fort Scott, for this purpose the Department of Agriculture entered into an agreement with the Parkinson Sugar Co., under which the Department undertook to supply and erect all the necessary machinery for carrying on the process, the Company, on the other hand, finding the necessary buildings and steam-power. Accordingly a diffusion battery of fourteen cells was erected, with calorisators and other apparatus as required; each cell held about 1900 lbs. of sorghum chips moderately packed.

After a full description of all the machinery employed come a number of tables showing the results of the analyses of the mill juices, diffusion juices, carbonatated, sulphured, and other juices, waste waters, waste chips, syrups, &c., obtained during the progress of the experiments.

A few experiments were made to determine whether or not double carbonatations could be practised with sorghum juices. When two- to four-tenths of a gramme of lime per litre were left in the juice of the first carbonatation the filtration took place more readily, and the juice was purer. In double carbonatation some additional lime is added to the hot juice from the filter-presses, and the injection of CO_2 is continued until the liquid is neutral. Fans were put up to give this method a trial, but, owing to the juice being so rich in glucose, the method of procedure was not found to be applicable.

The analyses of the samples of cane used show very great variations in their composition, varying as they do from a quality of high sugar-producing value to one worthless for this purpose: the general poor character of the cane was, however, owing to its being too ripe.

To determine the amount of sucrose in the cane by direct estimation, fresh sorghum canes were cut into chips, and digested in boiling water in closed vessels for one hour; the results by two methods gave 8·71 and 7·98 per cent, the amounts calculated from the composition of the juice at 89 per cent being respectively 8·68 and 7·82 per cent,—a very close agreement.

The direct estimation of sugar in the chips was made as follows:—48·9 grms. of chips were placed in a flask and water added up to 305 c.c., the fibre occupying about 5 c.c. After heating and shaking for about an hour the liquor was filtered, 100 c.c. (=16·3 grms. of chips) were treated with acetate of lead, made up to 110 c.c., and polarised. After adding one-tenth, the reading gives the percentage of sucrose present.

The effect of frost on the manufacture is shown by the following figures:—Before the frost the ratio of glucose to sucrose in the diffusion juices was 39·95 per cent, and after the frost it increased to 68·15 per cent, but when once the process of inversion has commenced it goes on easily and rapidly under the combined influence of time and an elevated temperature.

In reviewing the work done Mr. Wiley concludes that the experiments were an absolute failure as far as demonstrating the commercial practicability of manufacturing sorghum sugar. The causes of this failure were, he thinks, due to:—

1st. Defective machinery for cutting the canes and removing the exhausted chips.

2nd. The over-ripeness of the canes, the time that elapsed after cutting before the chips reached the battery, and the hard frost which set in on October 1st.

3rd. The inversion of the sucrose, owing to the chips being under pressure for too long a time.

4th. The process of carbonatation, as employed, secured a maximum of sugar, but failed to make a marketable molasses.

These difficulties can probably be removed, being as they are to a great extent mechanical; but the chief thing to do is, as Mr. Wiley says, to produce a sorghum plant with a reasonably constant percentage of crystallisable sugar: this must be done by improved seed selection.

When these experiments were completed another series was commenced with sugar-cane. The same trouble with mechanical defects was experienced as before, and the temperature for the diffusion used for sorghum (70° C.) was found to be too low with sugar-cane; it was therefore gradually raised to 90° C. before satisfactory results were obtained.

Tables of results of analyses similar to those made of sorghum then follow, the results showing in the most convincing manner that this process of treating sugar-cane gives an increased yield of 30 per cent over that obtained by the best milling and subsequent treatment which has ever been practised in any country.

Carbonatation tends to increase the yield in three ways:—

1st. It diminishes the contents of glucose.

2nd. When carefully done there is hardly any loss of sugar, the wasteful process of "skimming" being entirely done away with.

3rd. The action of the excess of lime and its precipitation by carbonic acid on the substances in the juice increase the ability of the juice to crystallise.

Thus, though we regret the failure of the experiments with sorghum, they have been useful in causing plant to be erected which has proved to be so thoroughly successful in working sugar-cane.

Certain Points in Agricultural Chemistry, considered in reference to the Selection and Application of Manures for the Sugar-Cane in the Island of Barbadoes. By J. B. HARRISON. Barbadoes: "Globe" Newspaper Office. 1886.

THE pamphlet now before us was read before the Barbadoes General Agricultural Society on Nov. 9, 1886. The cultivation of the sugar cane is of great importance in that island. The average yield during the last three periods of seven years each has been a production of 47,700, 48,000, and lastly, since the introduction of the new system of manuring, 55,300 hogsheads per annum. Analyses of some of the Barbadoes soils are given, and attention is directed to the facts that while silica, alumina, iron peroxide, lime, &c., are present in large quantities, in each case nitrogen, potash, and phosphoric anhydride are present in only small proportions; and although the quantities per cent removed from the soil by the canes appear

to be very small, yet, when considered as pounds per acre, they are far from being insignificant; 0·1 per cent means about 300 lbs. per acre. In nine inches depth of soil the analysis shows that there is enough potash for 70, enough phosphoric acid for 200, and enough nitrogen for 37 successive crops of sugar-cane, but even all this is not in such a condition as to be available as plant food.

In selecting manures for the sugar-cane, their application must be considered in two lights. The first is in supplying the deficiency of any constituent which may exist, or in other words to put the soil into a condition to bear a good crop of any kind.

Mr. Harrison then discusses what must be done to keep up permanently the present state of fertility. This, he says, is partially done by the nitrogen contained in the rain and dew, by the absorption of ammonia, and possibly, though we do not think there are good grounds for his assumption, by the direct assimilation of nitrogen from the air by the soil; and after carefully going into the amount of manure absorbed by the plant and the quantity contained in the refuse which is returned to the land, he concludes that in order to maintain the standard of excellence there must be added, during the growth or immediately before the canes are planted, manures capable of supplying in an available form 34 lbs. of nitrogen, 44 lbs. of potash, and 25 lbs. of phosphates per acre. Having considered the first kind of manuring he goes on to discuss the second, that of feeding the plant. The object of this is to supply the plant with the manure or food it requires, and that in the most suitable form. This is a more difficult problem than the first one, and to get a thoroughly satisfactory answer it must be tried not only in one soil and in one climate, but in many; however, very little appears to be known with regard to the real manurial requirements of this plant, and reasoning from analogy has to be resorted to in order to get some ground to go on. This reasoning shows that besides chemical manure, a heavy dressing of pen or sheep manure should be applied before planting the canes, bearing in mind that, as the cane itself contains a sufficient supply of nitrogen for the early stages of its growth, a rapidly acting nitrogenous manure is not required; that ammonia salts are not available as food for young plants; and that, as nitrates would be lost by rain and drainage before the young plants were sufficiently developed to require them, the source of nitrogen should be mainly easily decomposable organic matter, such as blood, containing not more than 4 to 4½ per cent of nitrogen. If these and other recommendations are attended to Mr. Harrison hopes that the sugar-cane will still be able to compete with the beet-root, and thus restore the former prosperity of the island.

CORRESPONDENCE.

ON A FUNDAMENTAL LAW OF THERMO-CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Allow me to correct one or two errors in my paper in the Chemical News (vol. lv., p. 144), which I unfortunately did not notice before. On looking over my first calculations I find that the anomaly supposed to exist in the case of the nitrates disappears on examination, the value for $NaNO_3$ being erroneously stated as 96·220 instead of 106·220. This brings all the nitrates of the monad metals, except thallium, into agreement with the dyad metals, and thallium would agree if its heat of formation be 48·210 instead of 38·210, as no doubt it really is.

Again, I find that the value 124·661 for the reaction 4Am+3Cl, which I used as a starting-point for calculation, is the mean of the results of Thomsen and Favre. As they differ widely it would be better to take Thomsen's result alone, 119·613. This would increase the values of the thermal equivalents by 1·646 for monad, and twice that for dyad metals, while the values for the non-metals would be altered,—not, however, in a way to materially affect the subsequent results.

The following are some of the more important changes: H = 18·619, Cl = 20·706, Br = 9·751; O in hydrates 17·392, in oxides 3·600; S in MSH about −33·938, in M_2S −47·600, in M_2SO_4 135·384; C in M_2CO_3 101·981, and N in all nitrates 5·751.

Other alterations are easily made. My object in the above-mentioned paper was merely to draw attention to the law, and show how the thermal equivalents might be calculated.—I am, &c.,

C. A. Seyler.

TRANSPARENCY OF MOLTEN IRON.

To the Editor of the Chemical News.

Sir,—Mr. Turner (Chemical News, vol. lv., p. 163) has, I think, misunderstood my recent letter regarding the transparency of molten iron (Chemical News, vol. lv., p. 104). I intended no rash assertion, but merely stated the impression produced on myself and on two others who witnessed a casting, that the iron was transparent. The object of my letter was to invite the opinions of others,—not to make a definite statement. I have heard (I forget from whom) that gold in the molten state is transparent and green, and my sole object in writing you was merely to raise the question, so that those whose opportunities are better than mine might be able to confirm or disprove my impression.

I ought perhaps to mention that the temperature of the seemingly transparent iron was not very high, so that one was not dazzled by emitted light.—I am, &c.,

W. Ramsay.

DRINKING-WATER AND DISEASE.

To the Editor of the Chemical News.

Sir,—In view of Dr. Emmerich's experiments as to the effect of drinking the diluted sewage from healthy persons, there would seem to be but small danger lurking in excremental material known to have come from a non-pathological source.

An interesting case has recently come under my observation, which shows conclusively that even normal sewage may not be taken inwardly with impunity. Appended is the analysis of a cistern water from Albany, N.Y. The cistern is of the "filtering" type, the filtering wall being of some thickness. The property is owned and occupied by wealthy persons, and every care has been (presumably) exercised in keeping the premises in good order.

Suspicion was cast upon the water some months ago, but its use was continued under a belief in the cleanliness of the cistern.

Suddenly, with but a few hours warning, the entire household, one person excepted, was prostrated. The symptoms varied from intense nausea to great, if not dangerous, prostration.

Over a month has passed, and yet the effects of the poisoning are, in a measure, felt by those more severely attacked. The one person who escaped was the lady of the house, who did not drink the water.

Among those attacked were several children. Upon investigation it was found that both cistern lining and private sewer were defective, and that more or less direct communication existed between them. Up to the time of this outbreak none of the household had suffered from diarrhœa or kindred troubles, nor could I obtain any history of recent disease of any kind. The children attacked were on a short visit only.

What I particularly desire to call attention to is, that the sewage, which undoubtedly caused the trouble, was *normal*,—probably not *fresh*, but still *normal*.

The absence of nitrates would go some distance, moreover, towards showing that it was not very old.

To my mind the evidence seems pretty strong that "specific" germs are not essential to a sewage in order to make its presence in drinking-water strongly objectionable. It is greatly to be regretted that previous analyses of the water were not obtainable, as thereby it is possible some information might have been secured as to the relation of the figures of the analysis to the "poisoning-point" of the water.

Analysis: Parts per Million.

Free ammonia	15,000!
Albumenoid ammonia	2,800
Chlorine	46,000
Nitrates and nitrites..	traces

I am, &c.,

William P. Mason.

Rensselaer Polytechnic Institute,
Troy, N.Y., March 26, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 12, March 21, 1887.

Red Fluorescence of Alumina.—Lecoq de Boisbaudran.—The author now maintains that the fine red fluorescence studied by M. Becquerel is due to the presence of traces of chromium in ordinary alumina, and does not belong to the pure earth.

Use of Coal-Gas as a Constant Source in Experiments on Radiation.—Edouard Branby.—This memoir does not admit of useful abridgment.

On Antimony Tartrate.—M. Güntz.—The author finds that the method of preparing acid antimony tartrate indicated by Peligot, *i.e.*, precipitating with alcohol a saturated solution of antimony oxide in pure tartaric acid does not give a compound of definite and constant composition. He boils, instead, an excess of pure antimony oxide in a solution of pure tartaric acid until the liquid contains 2 mols. of the oxide to 5 mols. of the acid. The result is constant.

Detection and Determination of Alumina in Wine and in Grapes.—L. L'Hote.—The author evaporates 250 c.c. of wine down to a syrup in a platinum capsule and adds pure sulphuric acid. The carbonaceous mass after ignition in a muffle furnace at a low temperature, leaves a white ash. The ash is treated in a flask with 15 c.c. of nitric acid with the aid of heat. To the solution are added 100 c.c. of a solution of ammonium nitro-molybdate (prepared with 50 grms. molybdic acid per litre) and raised to a boil. The phospho-molybdic precipitate is filtered off and washed with water containing one per cent of nitric acid. To the filtrate are added ammonia and ammonium sulphide in excess, which keep the molybdenum in solution and throw down alumina and iron. The mixed precipitate is collected on a filter and heated in a platinum boat, first in air, then in a current of dry hydrogen, to reduce the iron oxide; when cold it is submitted to the action of dry hydrochloric acid at a red heat, when the iron is volatilised. The white residue in the boat, which may contain traces of silica, is moistened with hydrofluoric acid and a drop of sulphuric acid and heated to bright redness. The residue is then weighed. To prove that it is really alumina it is ignited before the blowpipe upon charcoal with a drop of solution of cobalt nitrate. All the wines examined (save one) whether plastered or not, were found to contain ponderable quantities of alumina. The same rule holds good with grapes, carefully plucked and washed with distilled water before analysis.

New Synthesis in the Fatty Series by Means of Aluminium Chloride.—Alphonse Combes.—By the reaction of aluminium chloride and acetyl chloride the author obtains acetyl-acetylacetic ether, a compound of this ether with aluminium, and an anhydride of diacetonic butyryl-butyrylbutyric acid.

Journal für Praktische Chemie.
New Series, Vol. xxxv., Part 3.

Some Rare Products of the Alkali Manufacture.—C. Rammelsberg.—The principal of these are specular iron, aluminium-calcium silicate combined with calcium sulphide, calcium silicate, crystallised lime, glauberite, gay-lussite, and crystalline silico-carbonate.

Studies in Chemical Dynamics.—W. Ostwald.—From the totality of the author's determinations there appears a complete proportionality between the coefficients of the speed of chemical reaction and the electric conductivity in the bases, as it has been previously ascertained to be the case in the acids.

New Chemical Examination of the "Kochbrunnen" (so-called Boiling Well) at Wiesbaden and Comparison of the Results with those obtained by the Author in 1849.—Dr. R. Fresenius.—The quantity of the main ingredients of the Kochbrunnen, the alkaline chlorides, and indeed the chlorides altogether, is practically unchanged in the last thirty-six years. Almost the same may be said of the alkaline-earthy sulphates. Lime and magnesia as carbonates have decreased slightly but perceptibly. Ferrous and manganous oxides have increased. The quantities obtained in 1849 for lithium, arsenic, and phosphoric acids are not comparable, as the methods for their determination then known were not sufficiently accurate. The total yearly amount of solids dissolved in the water of the Kochbrunnen is 1,656,735 kilos.

Constitution of Trimethylene-tricarbonic Aeid.—A. Michael.—This memoir does not admit of useful abstraction.

A Further Light on the Researches of Herr Julius Thomsen.—F. Weil.—The author contends that, as Herr Thomsen, by the use of his heated universal burner, finds the combustion heat of benzol higher by 11,400 cals. than by its volatilisation in a current of cold air, the only conclusion open is that such high values must depend on a transfer of heat from the burner to the calorimeter.

Indium and Gallium as Transferrers of the Halogens.—C. Willgerodt.—The author's experiments prove that indium and gallium rank among the good transferrers of halogens, provided that the commercial specimens of these metals are not contaminated with other transferrers.

Biedermann's Central Blatt für Agrikultur Chemie.
Vol. xv., Part 10.

Influence of Woods on the Heat of the Air and of the Soil.—Prof. Th. Nördlinger.—During the day the air in a wood is cooler than in the open country, but warmer during the night. Hence a forest climate is less extreme than that of the fields. The average annual heat of the soil in woods is decidedly less than in the open.

Pre-determination of the Minimum Temperature for the Night.—Dr. Köppen.—In the six months from March to August the lowest temperature for the night is almost exactly equal to the dew-point at 9.30 p.m.

The Microbia of the Soil.—E. Laurent.—The author undertakes to test the conclusion drawn by Duclaux from his experiments, that plants cannot utilise the more complex nutrient matters unless these are resolved into simpler states by the action of microbia. He finds that the activity of microbia in humous soils has a great effect upon the nutrition of plants. It must be remembered that the plants in the sterilised soil would find a certain quantity of assimilable matter which the microbia had produced before their destruction.

The Evaporation of Water from the Soil and from Plants.—F. and H. Marie Davy.—The amount of water carried away by the drains cannot be calculated from the rainfall.

An Examination of the Manurial Value of the Gilchrist and Thomas Slag.—Wrightson and Munro.—From an English source.

Formation of Glykuronic Acid in Fasting Animals.—H. Thierfelder.—Animals suffering hunger still form carbohydrates for which the only source must be the albumen of the body.

Contribution to a Knowledge of the Starch Group.—F. W. Dafert.—Starch cannot be considered as a chemical individual, but as a more or less fluctuating mixture of a number of chemical compounds, such as starch, cellulose, granulose, dextrine, sugar, proteine bodies, amides, fat, and ash. The disputes concerning the formula of starch are idle.

The Occurrence of Cholesterine in Vegetable Fats.—E. Heckel and Fr. Schlagdenhauffen.—From the *Comptes Rendus.*

Occurrence of Cholesterine in the Carrot.—A. Arnaud.—From the *Comptes Rendus.*

Development of the Sugar Beet.—Aimé Girard.—From the *Comptes Rendus.*

Examination of the Seeds of G. arboreum.—M. Sace.—From the *Comptes Rendus.*

New Method of Determining the Fat in Milk,—Dr. A. Cronander.—The apparatus is founded upon Hoppe-Seyler's and Soxhlet's principle of agitating the milk with ether and potash-lye. The fat dissolves in the ether and floats upon the surface. Cronander determines the fat present in the ether, not aræometrically, like Soxhlet, but by evaporating off the ether and measuring the volume of the fat remaining.

On Two Commercial Substitutes for Milk.—Prof. J. König.—Analyses of "Milsaline" and "Lactina-Bowick," two proprietary articles advertised for the nourishment of calves.

Journal de Pharmacie et de Chimie.
Series v., Vol. xv., No 3, Feb. 1, 1887.

Experimental Researches on the Solubility of the Medicinal Salts of Quinine.—J. Regnauld and E. Villejean.—A pharmaceutical paper. The results obtained by the authors are given in the form of tables.

Etherification of Sulphuric Acid in "Eau de Rabel."—M. Gautherand.—A purely pharmaceutical paper.

Detection of Wheat-Starch in Chocolate.—Dr. Pennetier.—The author pulverises 2 grms. of the sample, washes it upon a filter, firstly with water to remove sugar, then with alcohol to extract the colouring-matter, and lastly with ether to eliminate fatty matter. He then dries the filter and grinds up the mass anew, so as to have a perfectly homogeneous powder. He then weighs out 1 c.grm. of this powder and triturates it in an agate mortar successively with one, two . . . six drops of the following liquid:—Distilled water 1 vol., glycerin 2 vols., the whole mixed with 5 per cent of the officinal mixture of iodine. When this reagent has coloured the starch he makes six microscopic preparations so as to utilise the whole of the material. He uses slips of 22 m.m. across and observes with Nachet's object glass No. 5 (old) or 7 (new) and with the eye-piece No. 1. He then counts up in each preparation the number of granules of wheat starch contained in ten microscopic fields. He finds, however, that this method is inapplicable if the adulteration exceeds 10 per cent.

Studies on Cannabine.—Dr. F. Roux.—The author finds that the active part of Indian hemp is the resin. The alcoholic extract produces exciting properties, whilst the ethereal extract is inert.

Sterilisation of Hypodermic Solutions.—M. Girling.—A medical paper.

Urea, Phosphoric Acid, and Sugar: their Relations in Urine.—H. Bretet.—A paper of no special chemical interest.

On Saccharine Urines.—C. Mehu.—Of no chemical interest.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxvii., Part 3.

Condensations of the Aldehyds with Phenoles and Aromatic Amines.—L. Claissen.—The author studies the reactions of β-naphthol and benzaldehyd, of β-naphthol and acetaldehyd, and of benzaldehyd and β-naphthylamine.

Researches on Gold.—G. Krüss.—From the above researches it appears that three stages of oxidation of gold, the existence of which has not hitherto been doubted, cannot be formed. Gold has only three oxides, the aurous, auro-auric, and auric oxides. By the formation of these three stages of oxidation gold takes the intermediate position between platinum and mercury, which accords with its atomic weight.

On Chinoline.—E. Lellmann and H. Alt.—The authors give a comparative table of their chinolin-anacarbonic acid, and of the chinolin-anacarbonic acid of Schlosser and Skraup.

On Chinoxaline Bases.—O. Hinsberg.—The chinoxaline bases are, for the most part, sparingly soluble, and have very characteristic properties, their salts having a yellow or a red colour.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série, Vol. i., November, 1886.

This issue contains no chemical papers.

MISCELLANEOUS.

Electric Gas Lighting Apparatus.—Among the many applications of electricity which are now being brought before the public we note the introduction, by Messrs. Woodhouse and Rawson, of an automatic electric gas lighter, by which means any kind of gas-burner can be turned on, lighted, and turned off by the action of an electric current; by pressing a button the current is sent round the coils of an electro-magnet, and causes an armature carrying a circuit-breaker to vibrate; at the end of the armature is a pawl which, acting on a ratchet-wheel, causes it to rotate, and thus opens the gas tap; a spark from a coil lights the gas, and when the ratchet-wheel has rotated two-thirds round the commutator shunts the current into another circuit. By pressing a second button the armature again causes the ratchet-wheel to revolve one-third round and cut off the gas. The commutator automatically cuts off the current at the end of either operation. Another form of lighter, which can be fixed to any burner, automatically lights the gas when the tap is turned on by hand.

Influence of Heat upon the Combination of Sodium Monosulphide with Water of Crystallisation.—C. Götlig.—The composition of the compounds formed on treating alcoholic sodium hydroxide with hydrogen sulphide depends not alone on the strength of the alcohol, but directly or indirectly upon the temperature.—*Journ. für Prakt. Chemie.*

Prof. H. G. Seeley's Geological Field Class.—It is intended to form a class, including beginners and advanced students, this summer, in the same way as last year, for the study of Geology near London, to be conducted on Saturday afternoons, by Prof. H. G. Seeley, F.R.S., King's College. The science of Geology has been reduced in its general principles to simple and easily understood rules, a knowledge of which enables the student to take an intelligent interest in the mineral structure of the earth around him, and students so disposed should take advantage of this class for the purpose of practical study. "Fifty years of ever brightening science" has gradually lifted the veil which hung around this study, and shown the forces of nature which have rough hewn and afterwards carved and sculptured the surface of the earth. The country around London is very accessible and suitable for the study of Geology. Even in railway travelling those who have tried it know how pleasant is the art of reading the volume of history unfolded by a railway journey through a rolling country, where the companies have made clean cuttings through strata, which are its successive chapters. Applications for tickets should be made at once to either of the Hon. Secretaries, Nicol Brown, F.G.S., 7, Princess Road, Brownswood Park, South Hornsey, N., or to W. W. R. May, 16, Bethune Road, Manor Road, Stoke Newington, N.

MEETINGS FOR THE WEEK.

MONDAY, 18th.—Medical, 8.30.

TUESDAY, 19th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Society of Arts, 8. "South Africa," by Major-Gen. Sir Charles Warren.
—— Royal Institution, 3. "Electricity," by Dr. Hopkinson, M.A., F.R.S.

WEDNESDAY, 20th.—Society of Arts, 8. "Electric Locomotion," by A. Reckenzaun.
—— Meteorological, 7.

THURSDAY, 21st.—Chemical, 8.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "The Chemistry of the Organic World," by Prof Dewar, F.R.S.

FRIDAY, 22nd.—Royal Institution, 9. "The Work of the Imperial Institute," by Sir Frederick Abel, F.R.S.
—— Quekett Club, 8.

SATURDAY, 23rd.—Royal Institution, 3. "The New Zealand Alps," by R. Von Lendenfeld, Ph.D.
—— Physical, 3. "On Delicate Calorimetrical Thermometers, and on the Expansion of Thermometer Bulbs under Pressure," by Prof. Pickering. "Note on Magnetisation," by R. H. M. Bosanquet. "On a Thermo-dynamical Relation," by Prof. W. Ramsay, Ph.D., and Sydney Young, D.Sc.

ERRATUM.—Vol. liv., p. 231, for "G. A. Gozdorf," read "G. A. Goyder."

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THE CHEMICAL NEWS.

Vol. LV. No. 1430.

AN INSTANCE OF THE POSSIBILITY OF DECEPTION BY THE SULPHUR EXTRACTIBLE BY ALCOHOL FROM VULCANISED RUBBER.

By BERTRAM BLOUNT.

In the course of an examination of a sample of indigo-dyed serge for foreign colouring-matters, I extracted the cloth with strong alcohol in a Soxhlet's apparatus, with the view of removing aniline dyes.

The solution thus obtained was reddish blue when hot, becoming much redder on cooling, and depositing a blue substance; subsequent investigation showed, however, that no aniline dye was present, but that the red body retained in solution by the cold alcohol was indirubin, and that the blue substance, which was almost insoluble in cold alcohol, was indigo itself.

Moreover, several other cloths known to be really dyed with indigo only, all yielded a blue solution with alcohol when similarly treated, although in most cases it became colourless on cooling, owing to the indigo being deposited and no indirubin being present.

That this indigo was obtained from the extremely intimate mixture of particles of fibre and dye which is characteristic of such a fast dye-stuff as indigo-blue, and was not derived from any small quantity of loosely adhering indigo that might chance to be present, was shown by the fact that even when the extraction was continued for several hours daily, for more than a week, the cloth still yielded a blue solution to the alcohol.

At the beginning of the extraction the alcohol was more deeply coloured than at a later stage; but a minimum was soon reached, and an approximately constant quantity of colour was removed at each discharge of the Soxhlet's tube, as far as could be judged by the tint of the solution.

I mention these details because I think that the solubility of indigo in hot alcohol, and the consequent need of thoroughly cooling the solution before the presence of an aniline dye can be detected, are not generally recognised.

The flask containing the alcoholic extract from the original cloth was set aside for a few days, when the presence of a small quantity of beautiful colourless needle-like crystals, mixed with the deposited indigo, was observed.

These were collected, the specifically lighter indigo washed away from them with alcohol, and preserved in a small corked tube, their examination being deferred till a larger quantity should be available.

To procure a further supply some more of the cloth was treated with fresh alcohol, but this time directly in a flask, without the intervention of a Soxhlet's tube, as the object in this case was not to thoroughly exhaust the cloth, but merely to obtain—by having the alcohol at its boiling-point in contact with excess of cloth—as strong a solution as possible, so as to ensure the formation of the crystals on cooling.

Several extractions of the cloth were thus made, the resulting solutions mixed and set aside to crystallise; to my surprise nothing but indigo came down, even after standing for many days. A friend then suggested that the solution might be supersaturated, and that the addition of one of the crystals previously obtained might produce the desired effect. A crystal was accordingly added, but without result.

The possibility of the crystals having come from the apparatus itself then occurred to me. If so, it was obvious that something must have been present in the first-used apparatus which was absent in the second. I then remembered that in the former the Soxhlet's tube was connected to the vertical condenser *by a rubber cork*, while that connecting it to the flask was of ordinary cork, and in the latter no rubber at all was present.

It therefore seemed probable that the crystals were *sulphur* derived from that source, an hypothesis which was strengthened by the appearance of the crystals, which, instead of being colourless and nearly transparent, as at first, were now a dingy yellow and opaque: examination showed that this was actually the case.

It is noteworthy that the rubber cork had been previously boiled for some time in dilute caustic soda, to remove free sulphur, and that only its lower end was exposed to the alcohol vapour.

The ease with which sulphur is extracted from vulcanised rubber by hot alcohol and its misleading appearance, were recently the subject of a paper in the Chemical News, by A. G. Bloxam, and my experience only confirms the necessity for guarding against this source of deception.

23, Queen Anne's Gate, S.W.,
April 16, 1887.

THE HARDNESS OF METALS.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S.,
Lecturer on Metallurgy, Mason College, Birmingham.

Part I.

For many of the purposes to which metals are applied, the degree of hardness of the material is of the utmost importance. In some cases, as in the preparation of a knife-edge, a tool, or a cutting instrument, hardness is much to be desired; while in other instances, where tenacity is required, and the material has to be worked by a tool, special hardness is undesirable. Unnecessary hardness generally leads to loss of time, and extra expense in tools, and is often accompanied by weakness and brittleness in the material. Extra softness, on the other hand, is accompanied with destruction of wearing surfaces, blunted edges, and often also with diminished tenacity. A ready method for obtaining trustworthy comparisons of hardness is much to be desired.

The usual definition of hardness is somewhat as follows:—"A body is said to be harder than another when it can be used to scratch the latter, but cannot be scratched by it. (Daniell, "Principles of Physics," 1884, p. 230). The same writer further states that "Hardness is a property that cannot be measured." Though some objection is possible to the latter statement, it is well-known that the usual methods of determining hardness are entirely qualitative, and hitherto no accurate system has been proposed by which different degrees of hardness can be satisfactorily compared. The scale of hardness in common use was originally proposed by Moh, and is reproduced here for purposes of reference:—

1. Talc 2. Rock salt	Scratched by finger nail.
3. Calcite 4. Fluor 5. Apatite 6. Orthoclase	Scratched by a knife blade.
7. Quartz 8. Topaz 9. Corundum 10. Diamond	May be roughly distinguished by a file.

We are indebted to Dumas for one of the earliest attempts to classify metals in order of their hardness

* Read before the Birmingham Philosophical Society, Dec. 9, 1886.

(Brande, "Elements of Chemistry," 1848, 534). In the following list most of the common metals are arranged in order of hardness, depending upon the facility with which they can be scratched by various materials. It may be mentioned that window glass has a hardness of 5·6 on Moh's scale:—

Titanium, Manganese	Harder than steel.
Chromium, Rhodium	Scratch glass.
Nickel, Cobalt, Iron, Antimony, Zinc	Scratched by glass.
Platinum, Palladium, Copper, Gold, Silver, Tellurium, Bismuth, Cadmium, Tin	Scratched by calc spar.
Lead	Scratched by the nail.
Potassium, Sodium	Soft as wax, at 15·5° C.
Mercury, Liquid.	

Dumas's list, however, is obviously only valuable as a general guide to the variations in hardness between different metals. It makes no claim to quantitative measurement, and even the order of the arrangement is, in several instances, different to that adopted by later experimenters.

In the case of such metals as are used in the arts, and which require to be turned or filed, the workman can judge pretty accurately of the relative hardness by the behaviour of the material under his tools. But such experience is of little value for accurate observation, as it has no quantitative value, and will to some extent depend upon the workman's previous experience, and the form or character of the tool. One of the earliest attemps to find a numerical value for the relative hardness of metals was made by the officers of the United States Ordnance Department (Reports of experiments on the strength and other properties of metal for cannon, 1856). In these experiments a punch in the form of a pyramid was used, and was pressed on the metal to be tested with a force of 10,000 lbs. The softest metal used for cannon was bronze, and an indentation rather greater than was produced in this material was taken as a standard of comparison. In each case the volume of the indentation was found, and this served as a measure of the hardness. The standard volume was 3·33 cubic tenths of an inch; one-half this volume was described as a hardness of 2; one-tenth the volume as a hardness of 10, and so forth.

The following extracts illustrate the results obtained (Pole—"Iron Construction," p.p. 67, 99, 129):—

Bronze	1·36
No. 1 pig-iron	2·55
Wrought-iron	3·32
No. 2 pig-iron	4·15
No. 3 pig-iron	6·4
Hardest iron tried	10·1

These results are of great interest, not only as the forerunners of others obtained by later experimenters, with very similar methods, but also as being almost the only quantitative observations of the variations in hardness of cast-iron. Other experimenters have been content to speak of "steel," or "cast-iron," as if these substances possessed a definite hardness, while we know, as a matter of fact, that their hardness under different circumstances varies over, at least, several degrees on Moh's scale. But it will afterwards be shown that the method of indentation by pressure really does not give a correct expression of hardness. The amount of metal displaced by a given force will evidently depend, to a considerable extent, upon the tenacity of the material, and so the results quoted above must depend upon the resultant of at least two properties, and are, therefore, not correct expressions of relative hardness (For proof of this see Part III.). Hardness I understand to be the property whereby a body is enabled to blunt or wear away the edge of a tool used upon it. In this it differs from tenacity, which, though increasing the *force* necessary to be employed in cutting, does not wear away the edge of the tool. At a later stage it will be shown that, with metals in a state of purity, tenacity and hardness accompany each other; but this is not the case in alloys or in the various commercial varieties of iron.

In 1859 Messrs. Calvert and Johnson published a very interesting series of results of experiments on "The Hardness of Metals and Alloys" (*Phil. Mag.*, 4th series, xvii., p. 114). The method employed was in reality only a modification of that previously described, though the authors appear to have been unaware of the American experiments. A graduated bar terminating in a steel point was pressed by means of a weighted lever upon the surface to be tested. The point used was conical, being 7 m.m. long, 5 m.m. wide at the base, and 1·25 m.m. wide at the smaller end. The weights were added so as to cause the point to enter the metal operated upon 3·5 m.m. in half an hour. A number of common metals were tested, and also five pretty complete series of alloys. Some of the more important results are as follows:—

Staffordshire grey iron (No. 3)	1000
Steel	958 (?)
Wrought-iron	948
Platinum	375
Copper (pure)	301
Aluminium	271
Silver (pure)	208
Zinc ,,	183
Gold ,,	167
Cadmium ,,	108
Bismuth ,,	52
Tin ,,	27
Lead	16

In connection with alloys, it was shown that in the zinc-copper, tin-copper, and lead-tin series, the hardness was greater than that calculated from a mixture of the constituents, this being especially noticeable in the copper-zinc series. In the tin-zinc series, on the contrary, the hardness observed was slightly less than that calculated.

In considering these experiments, the objection previously mentioned in connection with the American results must be urged, that it is doubtful if the weight necessary to drive a punch a given distance into the metal would not depend at least as much upon the tenacity as upon the hardness. With this special form of experiment there is the difficulty of making the punch enter exactly 3·5 m.m. in just half an hour, and also the fact that in a number of cases the specimens operated upon broke under the pressure, sometimes even before the point had entered at all. Of the general accuracy of the observations themselves, however, we have proof in their agreement with similar experiments by Bottone.

Bottone (Chem. News, 1873, xxvii., p. 215) also appears to have overlooked the results of previous workers in this direction. Two methods were employed in his determinations, the first identical with that of Calvert and Johnson, except for an improved method of applying the pressure to the steel cylinder, which was made to indent the metal to be tested. The second method Bottone considered perhaps less exact, and was used in the case of brittle metals. A soft iron disc rotating with an invariable velocity was pressed with a constant force against the

metal to be tested. The time necessary to produce a cut of a definite depth was taken as a measure of the hardness of the material. The results may be expressed as follows:—

Manganese	1456	Aluminium	821
Cobalt	1450	Cadmium	760
Nickel	1410	Magnesium	726
Iron	1375	Tin	651
Copper	1360	Lead	570
Palladium	1200	Thallium	565
Platinum	1107	Calcium	405
Zinc	1077	Sodium	400
Silver	990	Potassium	230
Iridium	984	Diamond	3010
Gold	979		

Bottone concluded that the hardness so obtained was proportional to the specific gravity of the metal divided by its atomic weight, and gave a number of examples to prove this statement. To these experiments we have to urge the objection brought against other determinations by a similar method, namely, that the depth of the indentation produced would depend upon the combined tenacity and hardness of the material.

It will be found on comparison of the results of Calvert and Johnson with those of Bottone, that in those cases where the same metals have been separately examined the order of hardness is very similar. This is illustrated in the following list:—

Calvert and Johnson.		*Bottone.*	
Iron	948	Iron	1375
Platinum	375	Copper	1360
Copper	301	Platinum	1107
Silver	208	Zinc	1077
Zinc	183	Silver	990
Gold	167	Gold	979
Cadmium	108	Cadmium	760
Tin	27	Tin	651
Lead	16	Lead	570

It will be seen, however, that the quantitative values of the hardness given by the two series of experiments is very different. Thus, as examples, we have the following approximate values:—

Calvert and Johnson $\frac{Fe}{Cu} = 3\ \frac{Fe}{Pb} = 58\ \frac{Pt}{Zn} = 2\ \frac{Cd}{Sn} = 4$

Bottone $\frac{Fe}{Cu} = 1\ \frac{Fe}{Pb} = 2\tfrac{1}{2}\ \frac{Pt}{Zn} = 1\ \frac{Cd}{Sn} = 1$

It is obvious from these values that the numbers given to represent the hardness of the different metals are only correct under the circumstances of the experiment. An interesting question arises as to the cause of the marked difference in the numerical values obtained. The explanation is probably to be found in the fact that in Calvert and Johnson's experiments the weight was *gradually* applied during the space of half-an-hour. As a natural consequence, plasticity is an important factor, and the plastic metals—tin, lead, and cadmium—yield very low values. Bottone appears to have applied his weights more rapidly, and naturally obtained higher values.

Reference has been made to the fact that the force required to make a given indentation would depend, at least in part, on the tenacity of the material. It is therefore interesting to compare the hardness results previously quoted with the tenacity of the same metals as given by other observers. In 1809 M. Guyton-Morveau published the results of experiments on the tenacity of the common metals, as measured by the weight in kilos., supported by a wire 2 m.m. in diameter (*Annales de Chemie*, 1st series, lxxi., p. 189). To the nearest whole number his results are as follows (p. 194):—

Iron	250	Gold	68
Copper	137	Zinc	50
Platinum	125	Tin	16
Silver	85	Lead	6

A much more extensive series of experiments was performed in 1841-44, by M. G. Wertheim (*Ann. Chim. et Phys.*, 3rd series, xii., p. 385; xv., p. 114). In the following table is given the tenacity of the commoner metals, the values being in kilos. per square m.m. In each case the metal was annealed, and used in the form of wire, the weights being added quickly:—

Iron	50·3	Zinc	14·4
Copper	31·6	Gold	11·0
Platinum	26·7	Cadmium	4·8
Silver	16·4	Tin	3·6
		Lead	2·0

It is interesting now to compare the results of the different observers. This is done in the following table:—

Hardness.

Moh's Scale.	Calvert and Johnson.		Bottone.	
5	Iron	948	Iron	1375
5—4	Platinum	375	Copper	1360
3—2½	Copper	301	Platinum	1107
3—2½	Silver	208	Zinc	1077
	Zinc	183	Silver	990
3—2½	Gold	167	Gold	979
	Cadmium	108	Cadmium	760
2	Tin	27	Tin	651
1½	Lead	16	Lead	570

Tenacity.

	Guyton Morveau.		Wertheim.	
5	Iron	250	Iron	50·3
5—4	Copper	137	Copper	31·6
3—2½	Platinum	125	Platinum	26·7
3—2½	Silver	85	Silver	16·4
	Gold	68	Zinc	14·4
3—2½	Zinc	50	Gold	11·0
	—	—	Cadmium	4·8
2	Tin	16	Tin	3·6
1½	Lead	6	Lead	2·0

An examination of this table shows that, according to the experiments referred to, the order of the common metals for hardness and tenacity is practically the same. It has previously been mentioned that Bottone stated the hardness of the common metals varied as the specific gravity divided by the atomic weight. But Wertheim had stated thirty years earlier that the *tenacity* of a metal varied as the specific gravity divided by the atomic weight. It will be seen that what Wertheim first stated to be the case in relation to tenacity, Bottone quite independently afterwards claimed to be true of hardness.

The fraction $\frac{\text{atomic weight}}{\text{specific gravity}}$ we know as the "atomic volume," hence $\frac{\text{specific gravity}}{\text{atomic weight}}$ will vary inversely as the atomic volume, or, in other words, as the number of atoms in a given space. Hence the statements of Wertheim and Bottone, if true, would show that both hardness and tenacity vary directly as the number of atoms in a unit space.

It has been previously stated that the method adopted in the determinations of hardness depended, at least to some extent, upon both tenacity and plasticity, and it is doubtful to what extent the method of experiment affected the close agreement between the order of the metals for tenacity and hardness. But in spite of this defect there can be no doubt that the hardness of the common metals does agree pretty closely with their tenacity, and that these vary in some measure with the atomic volume.

It has been suggested that in attempting to measure hardness and tenacity we are only really trying to measure the same force by two different methods. Such an idea is incorrect. Doubtless both hardness and tenacity depend upon cohesion, and this again upon the number of mole-

cules in a given space; but, nevertheless, hardness and tenacity are distinct physical properties. For instance, in the case of cast-iron, special hardness is not accompanied by high tenacity; on the contrary, the tensile strength of a hard iron may usually be increased by rendering the metal softer. Probably a good example of the difference between tenacity and hardness is furnished in the case of a sandstone. Such a material, owing to the hardness of its particles, rapidly wears away the edge of a tool used in working it, while the tenacity is often very low. We see, therefore, that tenacity depends on the strength of the material, *as a whole*, while hardness varies with the tenacity of the *particles* of the mass.

When the tenacity is uniform throughout, or, in other words, when the material is perfectly homogeneous in structure, tenacity and hardness vary together directly as the number of physical atoms.* Hence in the common metals, which are homogeneous, we find tenacity and hardness follow in the same order, and apparently depend upon the same cause. It may be noted that the metal which is least regular in this respect—namely, zinc—is also the most crystalline. Also that annealing, which diminishes the density of a metal, decreases its tenacity and hardness; while the density, tenacity, and hardness increase together by hammering or cold rolling.

In the case of the vast majority of substances, however, some definite crystalline or other structure is met with, and the material corresponds more or less closely to the example of the sandstone previously mentioned,—consequently tenacity and hardness do not follow according to any such simple rule as that above given. Accepting these statements as correct, it follows that in any trustworthy method of determining hardness the results obtained should closely agree with the tenacity in homogeneous substances, while in non-homogeneous materials it should not follow according to any definite rule.

Conclusions.

1. That hardness and tenacity are distinct physical properties.

2. That methods for the quantitative determination of hardness, depending on the production of an indentation of considerable size, have the following disadvantages:—

a. The results are influenced by the tenacity of the metal.

b. Owing to plasticity the results vary according to the time taken to produce the indentation.

c. Brittle substances are apt to be broken by the pressure.

3. That in substances which are homogeneous in structure the hardness and tenacity generally vary according to the number of atoms in a given space.

4. That in substances possessing a definite structure the above rule does not hold good.

(To be continued).

* I use the expression "physical atom" to express the idea that the atom of the physicist and chemist are not identical.

† *Annals N.Y. Academy of Sciences*, vol. iii., p. 159 (1885). Also CHEMICAL NEWS, vols. li. and lii.

SUPPLEMENT TO A CATALOGUE OF CHEMICAL PERIODICALS.†

By H. CARRINGTON BOLTON.

I. ADDENDA TO TITLES.

1. AGENDA DU CHIMISTE. (Established in 1877.)

5. [b] Sachregister zu den drei Jahrgängen 1823, 1824, und 1825 oder Band VII.-XV. des JAHRBUCHES DER CHEMIE UND PHYSIK. Halle, 1826, 8vo.

13. [c] JUSTUS LIEBIG'S ANNALEN DER CHEMIE UND PHARMACIE. *From* Vol. 173 (1874) *the words* "und Pharmacie" *are dropped.*

14. Tables de la cinquième série des ANNALES DE CHIMIE (1874-1883) dressées par Gayon. 1 vol. 8vo. Paris, 1885.

92. [b] ANNALI DI CHIMICA [etc.] 80 vols. (I.-LXXX.), 8vo. Milano, 1845-84.
United with Rivista di chimica medica e farmaceutica, *and continued under the title*:

[c] Annali di chimica medico-farmaceutica e di farmacologia. Direttori, P. Albertoni, I. Guareschi; Condirettori, A. Pavesi, G. Colombo. Milano, 1885+.

99. JAHRESBERICHT * * * * DER REINEN CHEMIE. 1873-81. 9 vols, roy. 8vo. Tübingen, 1874-83.

149. [A] RÉPERTOIRE DE CHIMIE PURE ET APPLIQUÉE [etc.]. 4 vols., 8vo. Paris, 1858-62.

And simultaneously:

[C] Bulletin des séances de la Société chimique de Paris, publié par Adolphe Wurtz et Felix Le Blanc. 1858-62. 3 vols., 8vo. Paris, 1861-62.

[C] *united with* [A] in 1863 *and with* [B] in 1864, *forming* [a] *as given in the Catalogue.*

[D] Table analytique des matières contenues dans le Bulletin de la Société chimique 1re et 2e Séries, 1858 à 1874, et dans les Répertoires de chimie pure et de chimie appliquée; suivie de la Table alphabétique des auteurs' dressés par Ed. Willm. 1 vol., 8vo. Paris, 1876.

159. RIVISTA DI CHIMICA, MEDICA E FARMACEUTICA. *United* in 1885 *with* Annali di chimica applicata [etc.]. *See* 92 [b].

180. ZEITSCHRIFT FÜR PHYSIOLOGISCHE CHEMIE. Sach- und Namen-Register zu Bund I.-IV., Strassburg, 1882.

II. NEW TITLES.

183. BULLETIN DE L'ASSOCIATION DES CHIMISTES DE SUCRERIE ET DE DISTILLERIE DE FRANCE ET DES COLONIES. 8vo. Paris, 1883+.

184. BULLETIN OF THE CHEMICAL SOCIETY OF WASHINGTON. 2 Nos., January '84 to '87. Washington, [D. C.], 1886-87.

185. CHEMIKER (Der) UND DROGIST. Haupt-Organ für Chemiker, Drogisten, Gewerbtreibende, etc. Herausgegeben von H. Krätzer. 4to. Leipzig, 1885+.

186. CHEMISCH-TECHNISCHER CENTRAL-ANZEIGER, Fach- und Handelsblatt für Chemiker, Techniker Drogisten, Apotheker, Fabrikanten. Central-Insertions-Organ für die gesammten chemischen Industriezweige und deren Hilfsindustrieen. Verantwörtlicher Redacteur, Karl Barthel [*later* Otto Prinz]. Sm. fol. Leipzig, 1883-86+.

187. DEUTSCHE CHEMIKER-ZEITUNG. Centralblatt für die chemische Praxis und öffentliche Gesundheitspflege. Unter Mitwirkung bewährter Fachgelehrten herausgegeben und redigirt von Breslauer. 4to. Berlin, 1886+.

188. JOURNAL (THE) OF ANALYTICAL CHEMISTRY. Edited by Edward Hart. Associate editors, P. W. Shimer [and] John Eyerman. With the assistance of the following specialists: F. C. Blake, F. W. Clarke, Isaac Ott, V. C. Vaughan, H. W. Wiley. 8vo. Easton, Pa., 1887.

189. MEDDELELSER FRA CARLSBERG LABORATORIET. Udgivet ved laboritoriets bestyrelse. 2 vols., 8vo. Christiania, 1885-86+.

190. New York Analyst (The). Devoted to the interests of sanitary science, food, medicine, and the suppression of adulteration. Edited by Henry Lassing. 18 Nos., 4to. New York, 1885.

[This is successor to an American reprint of the Analyst, published in London; hence the above is styled: "New Series."]

From No. 19, Oct. 1st, 1885, *continued under the title:—*

[a] American Analyst. A popular semi-monthly review devoted to industrial progress, sanitation and the chemistry of commercial products. H. Lassing, editor and publisher. 4to. New York, 1885+.

191. Skandinaviens kemisk-tekniske Centralblad for Danmark, Sverige, Norge og Finland. Redigeret af G. A. Schmidt. 4 vols., 8vo. Kjøbenhavn, 1882-85+.

192. Supplemento annuale alla enciclopedia di chimica scientifica ed industriale, diretto dal Icilio Guareschi. 3 Nos. Torino, 1884-86+.

193. Tokyo Kagakkai Kaishi. [Editor] J. Sakurai. 6 vols., 8vo. Tokyo. June, 1880-86+. [Tokyo Chemical Society's Journal, Tokyo, Japan.]

194. Vierteljahresschrift über die Fortschritte auf dem Gebiete der Chemie der Nahrungs- und Genussmittel, der Gebrauchsgegenstände, sowie der hierher gohörenden Industriezweige. Unter Mitwirkung von Degener, Hochstetter, P. Lohman, Benno Martiny, Paack, Proskauer, Würzburg, L. Aubry, R. Sendtner, H. Will, von Peters, Weigmann, J. Mayrhofer, E. von Raumer, Röttger, herausgegeben von A. Hilger, R. Kayser, J. König, E. Sell. 8vo. Berlin, 1886+.

195. Zeitschrift für die chemische Industrie, mit besonderer Berücksichtigung der chemisch-technischen Untersuchungsverfahren. Herausgegeben von Ferdinand Fischer. Roy. 8vo. Berlin, 1887+.

196. Zeitschrift für physikalische Chemie, Stöchiometrie und Verwandschaftslehre. Herausgegeben von Wilh. Ostwald. Riga und Leipzig, 1887+.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending March 31st, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To The Water Examiner, *Metropolis Water Act*, 1871.

London, April 5th, 1887.

Sir,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from March 1st to March 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Altogether, the water supply during the past month has been most satisfactory. In the case of one Company's supply, a few of the samples have to be recorded as "slightly turbid," but this turbidity was entirely local, and due to an interference with the mains in the locality from which the samples were taken. The matters in suspension were, moreover, constituted entirely of mineral matter. The remaining samples, including the whole of those supplied from the Thames, were well filtered, clear, and bright. The proportion of organic matter in the water was appreciably below that of the preceding month's supply.

We are, Sir,
Your obedient Servants,

William Crookes.
William Odling.
C. Meymott Tidy.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, April 7th, 1887.

Mr. William Crookes, F.R.S., President, in the Chair.

Mr. A. H. F. Ruppel was admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. L. C. Daniell, The Brewery, West Bergholt, near Colchester; Frederick William Freeman, Melbourne House, St. Albans; Herbert James Gover, 28, Broad Street, Hanley, Staffordshire; Edward Day Gravill, 106, Loughboro' Park, Brixton, S.W.; Richard Nelson Jones, L.R.C.P., Swansea Hospital, Swansea; Leonard James Reade, 12, Larches Lane, Wolverhampton; Frank Traphagen, Ph.D., Staunton, Va.

The following Papers were read:—

33. "*Researches on the Constitution of Azo- and Diazo-derivatives.* II. *Diazoamido-compounds* (continued)." By R. Meldola, F.R.S., and F. W. Streatfeild.

The authors describe the results of their experiments on the decomposition of the dinitrodiazoamido-compounds and their ethyl-derivatives by cold chlorhydric acid. By a method described in the paper the products can be isolated and identified without the application of heat at any stage. The results show that the decomposition by cold acid takes place in the same manner as with hot acid, the most noteworthy instance being that of the unsymmetrical compound of m. p. 211° and its ethyl-derivative of m. p. 148°, both of which yield the same *mixed products* as when hot acid is employed. Thus the former compound yields *m*- and *p*-nitrodiazobenzene chlorides and *m*- and *p*-nitraniline, and the latter yields the same diazobenzene chlorides, together with two corresponding ethylnitranilides. The two ethyl-derivatives prepared respectively by the action of diazotised *p*-nitraniline upon ethyl-*m*-nitraniline (m. p. 187°) and of diazotised *m*-nitraniline upon ethyl-*p*-nitraniline (m. p. 174—175°) behave in an analogous manner when decomposed by cold acid, the first giving *p*-nitrodiazobenzene chloride and ethyl-*m*-nitraniline and the second *m*-nitrodiazobenzene chloride and ethyl-*p*-nitraniline. The mode of decomposition of the 187° m. p. ethyl-derivative and the facility with which it breaks up thus negatives the idea which had at first been formed as to this derivative being an amidoazo-compound. A more thorough examination of the substance has shown that it possesses all the characters of a true diazoamido-compound. It gives on complete reduction a mixture of ethyl-*m*-phenylenediamine

and *p*-phenylenediamine. A number of the salts of the dinitrodiazoamido-compounds are described in the paper, the chief result to which their examination has led being that only one atom of displaceable hydrogen is present in these compounds. It is pointed out in conclusion that the existence of *three* isomeric ethyl-derivatives containing *p*- and *m*-nitraniline residues is inexplicable by the generally received formula which admits only of the two modifications:—

(*p*) $NO_2 \cdot C_6H_4 \cdot N_2 \cdot Et \cdot C_6H_4 \cdot NO_2(m)$
and (*m*)$NO_2 \cdot C_6H_4 \cdot N_2 \cdot Et \cdot C_6H_4 \cdot NO_2(p)$.

This fact, combined with the difficulty which has hitherto been experienced in accounting for the identity of mixed diazoamido-compounds, has led Professor Meldola to propose a revision of the commonly accepted formulæ of these compounds.

Discussion.

Mr. Groves asked Professor Meldola whether the mixed diazo-compound yielded practically the para- and meta-nitranilines in the same proportions when it was acted on by cold and by hot hydrochloric acid; also whether different preparations of the compound yield the same results—that is, whether the substance is really homogeneous.

Mr. A. G. Green asked Professor Meldola whether the individuality of the compound $C_6H_4(\overset{(3)}{NO_2}) \cdot \overset{(1)}{N_2}H \cdot C_6H_4(\overset{(4)}{NO_2})$ and its ethyl-derivative of m. p. 147° was determined with certainty. Considering the tendency which certain nitro-compounds (*e.g.*, *m*- and *p*-nitraniline) have of forming tolerably stable molecular compounds with each other with fixed melting point lower than those of either constituent, it seemed possible that this diazoamido-compound (and its ethyl-derivative) might be such a molecular compound of the two isomers $C_6H_4(\overset{(3)}{NO_2}) \cdot \overset{(1)}{N} \cdot NH \cdot C_6H_4(\overset{(4)}{NO_2})$ and $C_6H_4(\overset{(3)}{NO_2}) \cdot NH \cdot \overset{(1)}{N_2} \cdot C_6H_4(\overset{(4)}{NO_2})$. This would explain the decomposition by acids into *m*- and *p*-diazonitrobenzene and *m*- and *p*-diazonitrobenzene and *m*- and *p*-nitraniline (or their ethyl-derivatives). The ethyl-derivative of m. p. 147° would then be a compound of the ethyl-derivatives of m. p. 175° and 187°. He suggested that the transference of the N_2-group from one amine to the other (especially in strongly acid solution as given in Professor Meldola's previous paper) might be explained by assuming that an inverse change to diazotisation can occur in a solution of a diazo-compound, resulting in the partial reproduction of the amine and nitrous acid, which latter would then diazotise the second amine.

Professor Meldola, in reply to Mr. Groves, stated that there was no doubt that the so-called unsymmetrical compound was a definite chemical substance and not a molecular combination of the dipara- and dimeta-compounds. This point had been fully considered in the paper, and the experiments which had led to this conclusion were described therein. With reference to the question whether the same quantities of decomposition products were obtained from all the dinitrodiazoamido-compounds when decomposed by acid under similar conditions, he stated that quantitative experiments had not yet been made, but that it was proposed to extend the work in this direction. As far as could be estimated, however, by the appearance of the precipitates (nitrobenzeneazonaphthols) and the nitranilines, it seemed that the compounds all gave about the same results. The question raised by Mr. Green as to the possibility of the unsymmetrical compound being a molecular combination of the other two dinitro-compounds, was substantially the same as that put by Mr. Groves, and did not therefore call for any further reply. With reference to Mr. Green's other suggestion, that diazobenzene salts might by a reverse action be transformed into aniline and nitrous acid, Professor Meldola said that so far as he was aware there was at present no evidence in favour of such a view, and that even if this assumption were granted it would not help to explain any of the difficulties connected with the diazo-amido-compounds.

34. "*Conjugated Sulphates and Isomorphous Mixtures of the Copper-magnesium group.*" By P. C. Roy, B.Sc.

Miss Aston and S. U. Pickering having recently called in question the accuracy of Vohl's conclusions, which are supported by Rammelsberg's investigation of 1854, the author has analysed the following salts, prepared according to Vohl's directions:—

(1.) Nickel-Cobalt-Potassium Sulphate.
(2.) Zinc-Manganese-Ammonium Sulphate.
(3.) Copper-Iron-Ammonium Sulphate.
(4.) Copper-Cobalt-Potassium Sulphate.
(5.) Copper-Magnesium-Potassium Sulphate.

From the result it would appear (1) that whenever two sulphates of the copper-magnesium group are dissolved together in equal molecular proportions, with the requisite quantity of an alkaline sulphate, and the solution is left to evaporate spontaneously, salts of the type—

$$x(M''SO_4 + M'_2SO_4 + 6H_2O) + y(M''SO_4 + M'_2SO_4 + 6H_2O)$$

are always formed, x and y being small integers. Thus in (1) $x:y = 2:1$, in (2) the ratio is as 9:2, and so on.

The first crop of crystals as a rule does not conform to Vohl's formula; in fact, in no single instance is there the ratio of equality between x and y. This is strictly in accordance with the behaviour of isomorphous mixtures, for the first crop is always rich in the least soluble component.

The author's conclusions tally with those of Rammelsberg; it is true that his analyses show that in many instances the component sulphates do not occur in *exact* molecular proportions, but this Rammelsberg justly attributes to the fact that it is often difficult to discriminate between any two successive crops.

Discussion.

Mr. Pickering said that Mr. Roy's experimental results entirely confirmed those obtained by Miss Aston and himself, although the conclusions which he deduced from them were very different. It seemed inconceivable that when solutions of the sulphates were mixed in the molecular proportions of 1:1 the crystals obtained should consist of the salts in different but still definite proportions, whereas if they were not mixed in this simple proportion the crystals were indefinite in composition. Mr. Roy's own experiments disproved such a view, for after the first few crystals had been deposited the solution would no longer contain the sulphates in the original proportion or 1:1, and yet Mr. Roy contended that this solution continued to yield crystals of definite composition. The whole question depended on whether an analysis of salts containing only 1·3 to 12 per cent of the metals was sufficiently accurate to determine whether the salt was definite or not. Mr. Pickering considered that it was not so. By taking x and y in the above formulæ to be small integers (not greater than 10), as Mr. Roy does, a formula could be obtained which would represent any indefinite mixture of the sulphates within the limits of analytical error. In the same way the crystals which Mr. Roy obtained from solutions of the copper and nickel salts mixed in indefinite proportions, and to which he says it would be absurd to assign any formula, would correspond exactly with the formula—

$$11CuSO_4, 2NiSO_4, 13K_2SO_4, 78H_2O,$$

if there were an error of only 0·25 per cent in the determination of the copper or 0·44 in that of the nickel; errors much smaller than some of those observed in duplicate analysis. The analysis of these salts, therefore, is quite incompetent to determine whether they are definite or not; it is only by performing whole series of experiments that conclusions of any value can be drawn, and these series, as Miss Aston and Mr. Pickering have shown, prove clearly that the composition of the crystals varies continuously with variations in the circumstances under which they are produced.

35. "*Suboxide of Silver*, Ag_4O." By G. H. Bailey and G. J. Fowler.

The authors have repeated the experiments of Wöhler, and find no evidence of the formation of an argentous citrate when argentic citrate is heated to 100° in a current of hydrogen. The change is a progressive one, the citrate undergoing reduction with the formation of CO_2 and H_2O. In an experiment in which argentic citrate had been exposed to hydrogen at 100° for 36 hours the residue after extraction with ether contained 85·8 per cent of silver, and by carrying the reduction still further there would in all probability be a complete transformation into metallic silver, water, and carbon dioxide, along with itaconic or the kindred acids. The oxide precipitated from the aqueous extract by means of potash contains metallic silver, and is only obtained in quantities too minute to admit of a determination of the relation of silver to oxygen of sufficiently decisive character.

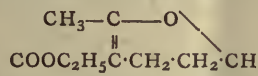
Faraday's suboxide of silver is also described, and found to be a modified form of ordinary oxide of silver.

Discussion.

Dr. Armstrong pointed out that at the recent Naturforscherversammlung at Berlin, von der Pfordten of Munich had adduced evidence in favour of the conclusion that an argentous oxide may be obtained.

36. "*Action of Trimethylene Bromide on the Sodium Compounds of Ethylic Acetoacetate, Benzoylacetate, Paranitrobenzoylacetate, and Acetone Dicarboxylate.*" By W. H. Perkin (jun.), Ph.D.

The sodium compound of ethylic acetoacetate, when treated with trimethylenebromide, is converted into ethylic methyldehydrohexonecarboxylate—



a colourless oil boiling at 225°.

This ethereal salt on hydrolysis yields the corresponding acid, $C_7H_{10}O_3$ (m. p. 118°).

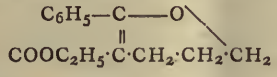
When treated with hydrobromic acid in the cold, the ethylic salt is converted into alcohol, carbonic anhydride, and the bromide of acetobutyl alcohol, thus :—

$$C_9H_{14}O_3 + H_2O + HBr = CO_2 + C_2H_5OH + CH_3{\cdot}CO{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}Br.$$

The free acid, $C_7H_{10}O_3$, on boiling with water, is converted quantitatively into carbonic anhydride, and acetobutyl alcohol, thus :—

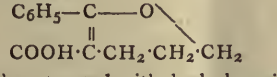
$$C_7H_{10}O_3 + H_2O = CO_2 + CH_3{\cdot}CO{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}OH.$$

Similar results were also obtained with the sodium compound of ethylic benzoylacetate; the principal product of the reaction being an ethereal salt of the formula—



(crystalline solid, m. p. 60°).

The corresponding acid,—



(m. p. 150°), when treated with hydrobromic acid, yields the bromide of benzoylbutyl alcohol,—

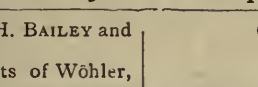
$$C_6H_5{\cdot}CO{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}Br,$$

and when boiled with water is decomposed into carbonic anhydride and benzoylbutyl alcohol,—

$$C_6H_5{\cdot}CO{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}OH.$$

Similar derivatives were obtained from ethylic paranitrobenzoylacetate.

The disodium compound of ethylic acetonedicarboxylate, when treated with trimethylenebromide, is resolved into ethylic methyldehydrohexonedicarboxylate,—



(colourless oil, b. p. 238—240°, 150 m.m.).

On hydrolysis this substance is first converted into its acid ethylic salt, $C_{10}H_{14}O_5$ (crystalline, m. p = 114°), and then into the dicarboxylic acid, $C_8H_{10}O_5$ (m. p. 160°).

The acid ethylic salt on distillation splits up quantitatively into ethylic methyldehydrohexonecarboxylate and carbonic anhydride. The acid, $C_8H_{10}O_5$, when boiled with water, is decomposed into 2 mols. of carbonic anhydride and acetobutyl alcohol, thus :—

$$C_8H_{10}O_5 + H_2O = 2CO_2 + CH_3{\cdot}CO{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}OH.$$

NOTICES OF BOOKS.

Our Daily Water-Supply. By C. E. Parker-Rhodes, late of H.M. Consular Service. London: E. W. Allen, and the Scientific Publishing Co. (Limited).

This little book, like the subject of which it treats, is of a somewhat multiform character, and discusses not alone scientific topics, but also matters not coming within our province.

In his preface the author enters upon the question of monopolies, and ventures upon the statement that "Monopolies are granted to individuals daily under Letters Patent." Now we contend, on the highest legal authority, that a patent cannot be rightfully termed a monopoly. Coke defines a monopoly as a grant or privilege to some person or corporation, by which the public are henceforward deprived of the right of doing something which was formerly open to them. Now a patent, on the contrary, merely secures to some person the right of doing something which was not open to the public, and which was, in fact, utterly unknown to them. Hence we cannot admit that patent-right has anything whatever to do with "the principle of Free Trade."

In successive sections Mr. Parker-Rhodes argues that filter-beds are, from their position, conducive to ill-health, that all surface-water is unwholesome, and that the water of artesian wells may be injurious by reason of the mineral matter in suspension or solution. Filter-beds are, of course, open to contamination from dust suspended in the atmosphere; but it savours of exaggeration to say that they are "surrounded by factories and working-class dwellings." Still less can we admit that all surface-water is unwholesome. The surface-waters from uninhabited and uncultivated districts, such as supply the water-works of Glasgow, Manchester, Leeds, Halifax, and Sheffield, are strikingly free from "germs of living corruption."

Water obtained through chalk, we are told, "is filtered to complete purity as to *insect* life." Elsewhere we read that "there is an impression that, in the process of cooking, the germs of *insect* life are destroyed by the heat of fire or by boiling water"; and again, "it [*i.e.*, soap] must be a source of constant propagation of *insect* life through the agency of soap-lather." Surely the author must be aware that the microbia to which zymotic diseases are now traced are not insects,—not, indeed, generally speaking, animals of any grade, but low vegetable organisms.

Mr. Parker-Rhodes is, however, perfectly right in his remarks on the part played by parasites, and by almost the entire class of two-winged flies, in transferring disease-germs from the infected to the healthy. Dr. B. W. Richardson may indeed tell his hearers to "drink no impure drink, wear no impure clothing, do no impure act." But so long as gnats, house-flies, &c., exist in the land, the most cleanly person is liable to be inoculated with disease from unknown sources. "Purity," by the way, is one of the

catch-words of the day, and, like the rest of them, has its connotation changed to suit the need of the speaker or writer.

The evils of hard water for domestic and industrial purposes are enforced at some length, and the Clark process is recommended as the remedy. To this method there is no conceivable objection where the hardness of the water is due to calcium carbonate held in solution by excess of carbonic acid. Wherever it has been fairly tried—*e. g.*, at Aylesbury—it has proved splendidly successful.

That "hard water conduces to blood-poisoning," and that "epidemics will continue their ravages so long as the water is used in its condition of hardness," are very hazardous propositions. Populous communities possessing a soft water supply are not found to have any well-marked advantages in their sanitary condition as compared with districts which consume hard waters.

Soft water, it is maintained, will not corrode lead water-pipes; yet in three Yorkshire towns, supplied with excellent soft water, the faculty are at present exercised with cases of lead-poisoning, and the water, as drawn from the taps, has been found not free from lead.

The author is of opinion that "our scriptural text 'Cleanliness is next to godliness' could be fully realised." The origin of this proverbial saying is doubtful, but it is certainly not scriptural, unless our most esteemed concordances are very much at fault.

Mr. Parker-Rhodes's subject is one of the utmost importance, and, in spite of Commissioners and Congresses, is still little cared for and little understood.

Mineral Physiology and Physiography. A Second Series of Chemical and Geological Essays, with a General Introduction. By Thomas Sterry Hunt, M.A., LL.D., F.R.S., &c. Boston: S. E. Cassino. London: Trübner and Co.

We have here a number of essays, all of them well worthy of attention, but not all of them fairly to be included under the heads "chemical and geological." These essays treat of "Nature in Thought and Language," the "Order of the Natural Sciences," the "Chemical and Geological Relations of the Atmosphere," "Celestial Chemistry from the Time of Newton," "Origin of Crystalline Rocks," "Genetic History of Crystalline Rocks," "Decay of Crystalline Rocks," "Natural System in Mineralogy," "History of Pre-Cambrian Rocks," "Geological History of Serpentines," and "Iaconic Question in Geology." Of these the first four will probably be considered the most profoundly interesting, touching, as they do, upon the origin of our elements, upon the nature of the chemical process, and the transition from the mineral to the organic. The writer considers that whilst the mode of generation which produces individuals presents no analogy to the phenomena of the formation of chemical species, yet the phenomena of metagenesis and metamorphosis "are to a certain extent prefigured" in the inorganic world.

As regards chemical combination, he rejects as mechanical Kant's view that "combination is inter-penetration, but accepts that of Hagel, that the chemical process is an identification of the different and a differentiation of the identical."

Returning to the question of the boundary line between the mineral and the organic, he quotes in a note the hylozoic views of Rosmini:—"The ultimate particles of matter are animate, each atom having united with it and forming its atomicity, a sensitive principle. When atoms chemically combine their sensitive principles become one. The unit of natural existence is neither force nor matter, but sentience, and through this all the material and dynamical phenomena of nature may be explained. From the unifications of these sensitive particles or elementary souls, which take place in the combinations of matter, higher and higher manifestations of sentience appear, constituting the various activities displayed in crystals, in plants, and in animals." It appears also that the late W. B. Carpenter, writing in Todd's "Cyclopædia of Anatomy and Physiology," contends that organisation and vital activity arise from the natural operation of forces inherent in elementary matter." According to Stallo "all movement is radically vital, and Allman pronounces life "a property of protoplasm." Graham, the discoverer of colloids, declared that "the colloid may be looked upon as the primary source of the force appearing in the phenomena of vitality."

Our author continues that—"When the chemist shall have succeeded by his synthesis in producing a colloidal albumenoid having the same chemical constitution as protoplasm, there is, as Barker has well said, reason to expect that it will exhibit all the phenomena of life which appear in the protoplasmic matter common to plants and animals."

But according to Reinke, protoplasm, as obtained from the fruits of *Ethalium septicum*, contains about forty proximate constituents, including scarcely 30 per cent of albumenoids. We cannot, without some degree of fear and trembling, imagine the constitution of such a complex, nor can we conceive of its originating except from life.

Dr. Hunt would apply to the study of all phenomena which are simply dynamic or chemic the name of abiophysiology, suggesting the term biophysiology for those which are characteristic of life. We must not forget here an appreciation of the views of Oken, as laid down in his "Physio-Philosophy" (*Naturphilosophie*). To follow the author in this survey would take us too far, but there is great truth and force in his remark that "Oken has been the inspirer and the teacher of the teachers of Science."

In the second essay Dr. Hunt lays down a classification of the sciences. In the first or descriptive group fall general physiography, mineral physiography, and biophysiography. The second group is, in like manner, subdivided into general physiology, mineral physiology (which latter includes physics, chemistry, and theoretical astronomy), and biophysiology.

In the essay on the "Chemical and Geological Relations of the Atmosphere" the author refers us to the opinion which he advanced as far back as 1867, that "the dissociation of elements by intense heat is a principle of universal application," and that "the further dissociation of our elements in stellar or nebulous masses may give us evidence of matter still more elementary than that revealed by the experiments of the laboratory." In 1874 he suggested that the green line in the spectrum of the solar corona may be a "more elementary form of matter" liberated by the intense heat of the solar sphere, and possibly corresponding to the primary matter conjectured by Dumas, having an atomic weight one-fourth that of hydrogen." This substance Prof. C. A. Young considers must be a near approach to the *Urstoff* (="protyle") of certain German speculators. It appears that in 1866 Hinrichs argued in favour of the existence of such a primitive matter, from a consideration of the wave-lengths of the spectra of the elements.

The essay on "Celestial Chemistry from the Time of Newton," originally read before the Philosophical Society of Cambridge in 1881, has been reproduced in the Chemical News. It is interesting as affording convincing proof to what a degree Newton anticipated the views of modern physicists and chemists who do not seem to have been acquainted with his writings. There is certainly much less "new under the sun" than we are apt to suppose.

Dr. Hunt's work may be recommended as rich in suggestive matter.

On some Physical Constants of Germanium and Titanium. By L. F. Nilson and Otto Pettersson.

This pamphlet is a reprint from the new *Zeitschrift für Physikalische Chemie*. It appears that the authors were

requested by Prof. Clemens Winkler to determine the atomic heat of germanium. This *savant* had been led, by certain facts in the chemical behaviour of the new element, to suspect that it must belong to the tetravalent group, an opinion which has been fully confirmed by the researches of the authors. They thought it useful, at the same time, to determine the atomic heat of the nearly-allied element titanium, so as to complete our knowledge of the physical constants of the tetravalent group. The folllowing table gives their most important results :—

Limits of Temperature.	Specific Heat.		Atomic Heat.	
	Ge.	Ti.	Ge.	Ti.
100°—0	0·0737	0·1125	5·33	5·40
211°—0	0·0773	0·1288	5·59	6·18
301·5°—0	0·0768	0·1485	5·65	7·13
440°—0	0·0757	0·1620	5·47	7·77

From these values it appears that at low temperatures both the elements possess an atomic heat lower by a unit than the normal figure.

All the series of experiments gave the same number for germanium, whilst titanium, even in the second series, reaches the normal atomic heat, and goes far beyond it at highest temperatures. In this respect germanium deviates from the common rule in a very remarkable manner.

The vapour-density of germanium tetrachloride was found to be in three experiments respectively 7·43, 7·46, and 7·44, the theoretical figure being 7·40. The tetraiodide gave at +440° 20·46, and at +658° 17·19, the theoretical value being 20·0. Germanium monosulphide gave at 1100° 3·54, and at 1500° 3·09, the theoretical density being 3·60.

The critical temperature of the vapour of the tetrachloride was found to be 276·9°. The tension of the vapour given in atmospheres ranges from 0·073 at 10·7° to 38 at 276·9.°

Eighth Annual Report of the Winnipeg Board of Trade, together with a Statistical Report of the City's Trade for 1886. Winnipeg : "The Commercial" Office. 1887.

The history of Winnipeg proper dates from the year 1874. Previous to that year it was known as the village of Fort Garry, and, although the population in 1870 (after the collapse of the first "Riel" rebellion) was only 215 souls, this village had been the leading Hudson's Bay Port in the north-west from the beginning of the century.

From the year 1874 the commercial prosperity of Winnipeg has been steadily increasing, and in five years the population had increased from 3000 to 8000, and the value of assessed property from about 2,000,000 dollars to over 3,500,000 dollars.

In the year 1881, however, what is known as the Winnipeg "boom" set in, and, although it was carried to a crazy excess, it was not altogether a bubble without substance, as the influx of actual settlers was immeasurably greater than that of any preceding year. The year 1882 opened with speculation at its highest pitch, but with the spring came a collapse; still the solid progress which had been made was too great to allow the collapse to be sudden, and the decline was so gradual that the real pressure of contraction was not felt until the following year. Real estate was still at a very high figure, the assessed value of property being fixed at 30,000,000 dols., an increase of nearly tenfold in little over three years. Prices and values then began to fall, until, in the midsummer of 1884, they had reached a more natural level, and a perfectly healthy, though not very active, state of trade once more existed.

The rebellion in 1885, in the north-west, again interrupted trade to a very considerable extent, but the recovery after its close was very marked. The year 1886, which is principally dealt with in this Report, has been one of moderate prosperity and steady improvement, but not sufficiently so to wipe away the lingering impression that some commercial depression still exists.

The total value of exports shows an increase of nearly 800,000 dollars over the previous year, principally due to the larger quantities of wheat and flour which are brought to the Winnipeg market. Prices, however, in this branch of trade do not improve, but the Manitoba millers are to be complimented in having in one year driven United States mill-products out of the British Columbia markets, where before they held undisputed command.

In closing the Report we note that regret is expressed at the want of progress in manufactures, and it is to be hoped that, now the Board is in a position to give better attention to this branch of trade, it will make improvement in this direction one of its principal studies.

On the Action, Therapeutic Value, and Use of the New Karlsbad Spring Salt along with its Relation to the Karlsbad Thermal Water. ("Ueber Wirkung, therapeutischen Werth und Gebrauch des neuen Karlsbader Quellsalzes nebst dessen Beziehung zum Karlsbader Thermalwasser.") By Dr. W. Jaworski. Vienna: The Author.

This pamphlet has no chemical interest. It may be important to physicians who make a speciality of the use of mineral waters.

CORRESPONDENCE.

ON THE NATURE OF SOLUTION.

To the Editor of the Chemical News.

Sir,—Professor Pickering's letter under the above title has just been brought under my notice. I regret exceedingly that I have unintentionally misrepresented Professor Pickering's views on solution. I was led to form the opinion that he had "abandoned the *definite* hydrate theory," by the following passages amongst others in his paper published by you last year (Chemical News, vol. liv., p. 215).

"The hydrate theory can be neither rejected nor accepted."

"Dissolution, I believe, is but one of the many results of apparently indefinite chemical combination."

"The evolution of heat accompanying dissolution will still be attributable, as on the ordinary hydrate theory, to the formation of chemical compounds, but the far greater complexity, and, consequently, instability of these, than of atomic hydrates, if I may so call them—"

Professor Pickering has not noticed my use of the word *definite*, or rather he interprets it in a different way, when he speaks of a *definite* molecular hydrate of the salt *probably never existing undissociated*. Surely this is indefinite enough.

There is one passage in his letter which I cannot pass without a protest. It is this—

"Dr. Nicol asks me at what number of molecules or atoms I draw the line for chemical combination."

I did nothing of the kind, as will be seen on reference to your report, which runs thus :—Professor Pickering "now believed in indefinite hydrate-aggregates of one molecule of salt and many hundred molecules of water. Where was the line to be drawn? He (Dr. Nicol) believed at the number of water molecules present in the solution; Professor Pickering stopped short of this : but where?"

How this can possibly bear the interpretation put upon it by Professor Pickering I fail to see. It was simply an easy mode of pointing out the apparent indefiniteness of his views and what I considered the close approximation of these to mine.

In answer to the remainder of his letter, I can only say

that when reliable experimental evidence and not hypothesis is brought forward in support of his views on solution, I will at once admit that the whole of the water present in a solution is *not* similarly related to the salt.—I am, &c.,

W. W. J. Nicol.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 13, March 28, 1887.

The Calorimetric Bomb and the Measurement of the Heats of Combustion.—MM. Berthelot and Recoura.—This method, first described by MM. Berthelot and Vieille in the *Annales de Chimie et de Physique* (vi., 546; and x., 433), has been applied to gases and to sparingly volatile bodies, and may be easily extended to all volatile compounds.

Variation of the Solubility of Bodies according to the Quantities of Heat Evolved.—G. Chancel and F. Parmentier.—A reply to a paper read by M. le Chatelier in the session of March 7, 1887.

Latent Evaporation-Heats of some very Volatile Substances.—James Chappuis.—This memoir does not admit of useful abstraction.

Study of the Alkaline Vanadiates.—A. Ditte.—The author describes seven potassium vanadiates, having the respective compositions VO_5KO; $2VO_5KO$; $3VO_52KO$; $3VO_5KO$; VO_52KO; VO_53KO; and VO_54KO.

Double Strontium and Sodium Phosphate and Arseniate.—A. Joly.—At the moment when the deposit of the double salt takes place the liquid must contain a sodium monophosphate and strontium chloride. A mixture of these two liquids gives at first no precipitate. But in a few moments, especially if the vessel is strongly rubbed, there is produced a crystalline precipitate of a dimetallic phosphate, and acid is set at liberty.

Certain Ammoniacal Compounds of Cadmium Chloride.—G. André.—On dissolving slowly and with refrigeration cadmium chloride in ammonia at 20 per cent, and passing through it, with constant refrigeration, a current of gaseous ammonia, there are formed anhydrous crystals of the composition $2CdCl,5NH_3$. Compounds have been obtained on other occasions containing definite proportions of water. Copper chloride yields a compound of a similar type.

Action of Nitric Acid on the Solubility of the Alkaline Nitrates.—R. Engel.—Nitric acid precipitates sodium nitrate from its watery solution. Each equivalent of nitric acid up to about the thirtieth precipitates, approximately, an equivalent of sodium nitrate. There appears here the joint result of two opposite actions, the one physical and the other chemical. The physical action exists alone when the quantity of acid added is small. The chemical action comes into play only when the proportion of acid becomes more considerable. It occasions at first merely a perturbation of the former phenomenon, but it soon becomes prodominant.

On the Metallic Propionates.—Adolphe Renard.—The author obtains propionic acid from the destructive distillation of resin. He has examined the aluminium, ammonium, barium, calcium, cadmium, chrome, cobalt, copper, iron (ferrous and ferric), lithium, magnesium, manganese (mercurous and mercuric), nickel, lead, potassium, sodium, strontium, and zinc salts.

Action of Hydrogen upon the Nitrogenous Derivatives of Turpentine.—C. Tanret.—These bodies, the *dihydro-camphenes* α, β, and β', agree in their composition and their reactions, but differ in their physical characters.

Homologues of Acetylacetone: A New General Method of Preparing the Fatty Acetones.—Alphonse Combes.—The decomposition by potassa of the diacetones, homologues of acetylacetone, furnishes a new method for producing the fatty acetones.

Journal de Pharmacie et de Chimie.
Series v., Vol. xv., No 4, Feb. 15, 1887.

Notes on the Assay of Opium.—MM. Adrian and E. Gallois.—The author takes a fairly representative sample, renders it homogeneous by pulverisation, and weighs out 5 grms. for determining the insoluble matter, and 50 grms. for the determination of the morphine. The 5 grms. are rubbed up in 50 grms. alcohol at 70 per cent, with which they are left in contact for about twelve hours. At the end of that time the whole is brought upon a filter, accurately tared, and the residue is extracted with alcohol of the same strength until it is completely exhausted. On weighing the dried residue there is found the weight of the water and the soluble matters. The 50 grms. of opium are put into a wide-mouthed flask with a ground glass stopper and accurately tared. We add, immediately, 200 grms. of alcohol at 70° and place the flask in a stove at 25° to 30°, agitating frequently. We make up the necessary weight when the examination of the 5 grms. is terminated, and after the complete disaggregation of the opium the mixture is left to cool for twelve hours. The weight is then carefully verified and made up if there has been any loss by evaporation. We filter and collect 400 grms. of the solution, representing the soluble part of 40 grms. of opium. The morphine is then precipitated with ammonia, washed with alcohol at 40°, dried, treated with chloroform, and dried anew as in Regnault's process, taking care to let it settle for thirty-six hours before collecting it.

On Saccharine Urines.—C. Méhu.—This paper requires the six accompanying figures.

On Ceresine extracted from Ozokerite.—M. Saurlandt.—Ozokerite is bleached by treatment with sulphuric acid at 180°. The acid is decomposed and the impurities are carbonised. The ozokerite should be previously dried at 130°.

Revue Universelle des Mines, de la Metallurgie, &c.,
Vol. xx., No. 3, November and December, 1886.

This issue contains no chemical matter.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., March, 1887.

Certain New Substances recently introduced into Industrial Chemistry.—Ivan Levinstein.—From the *Journal of the Soc. of Chem. Industry*,

Proportion in which Chloride of Lime loses its Active Chlorine.—From the *Journal of the Soc. of Chem. Industry.*

On Phosphorus Peroxide.—E. T. Thorpe and A. E. Tutton.—From the *Journal of the Chemical Society.*

The Alizarites of Iron and Chrome.—L. Liechti and and W. Suide.—From the *Journal Soc. Chem. Industry.*

Manufacture of Methylene Blue.—Otto Muhlhauser.—The author describes two processes, that with alkali-waste and that with zinc sulphide, both of which are now in use on the industrial scale.

Natural State and Origin of Petroleum.—Dr. Kræmer.—The author discusses the theories of Mendeleeff and Bryasson, and of Hœfer.

Action of Oils upon Metals.—J. J. Redwood.—From the *Journal Soc. Chem. Industry.*

Deposits of Ceriferous Clays.—Dr. J. R. Strohecker.—Already noticed.

German Chemical Patents.—Separation of Sugar from Treacle by Means of Lime and Magnesia.—L. Harperath.

Synthesis of a Kind of Sugar, Formose, analogous to Glucose.—O. Loew.

A New Diamido-dinaphthyl.—Dr. Julius.

Process for the Preservation of Yeast.—H. Boehm.—German Patent, 35,752.

Treatment of Tinner's Waste for the Recovery of the Tin.—T. F. Veasey.—V, No. 1002.

Improvements in the Electro-decomposition of the Chlorides, Bromides, and Iodides of the Heavy and the Alkaline Metals.—S, No. 3377.

Preparation of Aluminium and its Alloys.—L. Graubau.—G, No. 3815.

Process for Obtainlng and Separating the Sulphuretted Hydrocarbons derived from Non-saturated Carbides contained in Paraffins and Petroleum Oils, Sulphonic Acids, and Halogenous Combinations derived from these Sulphuretted Hydrocarbons.—Dr. E. Jacobsen.—J, No. 1299.

Process for Converting Heavy Petroleum Oils or Resins into a Material suitable for Oiling Wool.—J. G. Fayollet.—F, No. 2935.

Purification of Oils by Means of a Filtration combined with the Action of Steam.—G. Materne.—M, No. 4665.

Improvement in the Separation and Purification of the Grease of Wool destined for the Preparation of Lanoline.—No name of inventor.—F. No. 2774.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or auch trade notices as should legitimately come in the advertising columns.

The Analysis of Alum Cake.—We have received two letters with reference to the query signed "C. N. and Co." appearing in our issue for the 7th inst. Both writers protest that no information should be given to manufacturers and others which may enable them to dispense with the services of professional chemists. Whilst granting that their arguments are not without force, we must point out that the very object of the CHEMICAL NEWS and of all kindred publications, at home or abroad, is the diffusion of correct information on chemical subjects. If analytical processes are not to be made known to outsiders such a work as "Select Methods," by the Editor of this journal, ought to be suppressed, or to be supplied only to *bona fide* members of the profession.

MEETINGS FOR THE WEEK.

MONDAY, 25th.—Medical, 8.30.
TUESDAY, 26th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Society of Arts, 8. "Ornamental Glass," by J. Hungerford Pollen.
—— Royal Institution, 3. "Electricity," by Prof. W. E. Ayrton, F.R.S.
WEDNESDAY, 27th.—Society of Arts, 8. "Appliances for Saving Life from Fire," by Arthur W. C. Shean.
—— Geological, 8.
THURSDAY, 28th.—Royal, 4.30.
—— Telegraph Engineers, 8.
—— Royal Institution, 3. "The Chemistry of the Organic World," by Prof Dewar, F.R.S.
FRIDAY, 29th.—Royal Institution, 9. "The Rolling Contact of Bodies," Prof. H. S. Hele Shaw.
—— Society of Arts, 8. "Village Communities in India," by J. F. Hewitt.
SATURDAY, 30th.—Royal Institution, 3. "The Australian Alps and the Origin of the Australian Fauna," by R. Von Lendenfeld, Ph.D.

GEORGE BELL AND SONS' BOOKS.

COAL-TAR COLOURS: the CHEMISTRY OF. With special reference to their Application to Dyeing, &c. By Dr. R. BENEDIKT, Professor of Chemistry in the University of Vienna. Translated from the German by E. KNECHT, Ph.D., H.M. of the Chemistry and Dyeing Department in the Technical College, Bradford. 5s.

"This is an excellent little practical manual, dealing with a subject of great scientific and industrial importance. . . . . We cordially recommend the book."—*Nature.*

The ALKALI MAKERS' POCKET-BOOK: Tables and Analytical Methods for Manufactures of Sulphuric Acid, Nitric Acid, Soda, Potash, and Ammonia. By GEORGE LUNGE, Ph.D., Professor of Technical Chemistry, Zurich; and FERDINAND HURTER, Ph.D. Crown 8vo. 7s. 6d.

"It is a work which must of necessity find a place on the shelves o every chemist dealing with the subject."—*Analyst*, Dec., 1884.

EXPERIMENTAL CHEMISTRY. Founded on the Work of Dr. J. A. STÖCKHARDT. A Handbook for the Study of Science by Simple Experiments. New Edition. Revised by C. W. HEATON, F.I.C., F.C.S., Lecturer on Chemistry in the Medical School of Charing Cross Hospital, and Examiner in Chemistry to the Royal College of Physicians. Small post 8vo. 5s.

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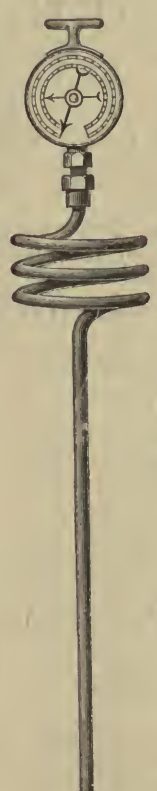
By Order. H. J. SMITH,
Vestry Hall, Kennington Green. Clerk to the Vestry.



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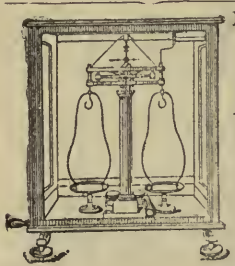

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THE CHEMICAL NEWS.

Vol. LV. No. 1431.

NOTE ON BISMUTHIC GOLD ("BLACK GOLD")

By R. W. EMERSON MacIVOR, F.I.C., F.C.S., &c.

Some years ago I had the pleasure of inspecting an excellent little collection of auriferous and other minerals belonging to Mr. C. MacIntyre of Baringhup, and among the specimens to which my attention was particularly called was a small quantity of what the miners called "black gold." This mineral, which my friend Mr. J. Cosmo Newbery, of Melbourne, had found to contain gold and bismuth only, and had named maldonite, was in the early days found associated with the gold obtained from the interesting "Nuggety Reef," Maldon, Victoria, and it was from this quarter that Mr. MacIntyre had obtained it. I learned that it was chiefly found in the granite veins that occur in the quartz composing the reef.

Having been presented with a few grains (0·285 grm.) of the ore, I examined it as thoroughly as was possible. It was without crystalline character that I could detect. It was malleable, and when newly broken had a bright silvery-white lustre, but on lengthened exposure to the air it slowly tarnished, becoming ultimately nearly black. Heated on charcoal it readily melted, and, after roasting in the oxidising flame, left a bead of gold, the charcoal being coated with the familiar film of oxide of bismuth. Sulphur and tellurium were absent. When dissolved in nitro-hydrochloric acid, the ore was found to contain a little siliceous matter. Analysis gave the following results:—

Gold	64·211
Bismuth	34·398
Siliceous matter.. ..	1·391
	100·000

If the silica be omitted and the metals calculated to make up 100, these results would indicate that the mineral has the formula Au_2Bi:—

	Found.	Theory.
Gold	65·117	65·322
Bismuth ..	34·883	34·678
	100·000	100·000

I hope to have an early opportunity of further examining this interesting natural alloy.

THE ASH OF *BOVISTA GIGANTÆA*.

By F. NETTLEFOLD, F.C.S.

The reputation of this fungus in "Rural Pharmacy," when dried as a styptic, led to an investigation of the ash.

These are dome-shaped, stalkless fungi, growing close to the ground in masses of the more luxuriant grass, which it is possible the mineral matter they collect from the soil may help to flourish.

Their size is about 12"—16" diameter. They are invested in a tough membranous integument, containing chiefly cellular tissue.

Dry substance at 100.. ..	8·35 per cent.
Water	91·65
Ash	0·571
,, on the dry substance ..	6·36

Analysis of the Ash.

	Calculated on plant.	Calculated on residue.
Insoluble residue in HCl ..	0·00	
Alumina	0·107	15·66 per cent.
Magnesia	0·020	2·93
H_2SO_4	0·060	8·79
SiO_2	0·003	0·44
CaO, mere traces	—	—
Phosphate of soda	0·381	72·18

It is noticeable that phosphate of soda is used to stop hemorrhage; and it may be owing to this substance that its reputation is due.

The solution is of an orange colour, and exhales the odour of urea, when heated.

THE DETECTION AND DETERMINATION OF VANADIUM IN ROCKS AND ORES.

By M. L. L'HOTE.

In a former memoir (*Comptes Rendus*, Dec. 7th, 1885) the author has given a process for extracting from vanadite the totality of its vanadium in the state of vanadyle chloride, by utilising the different volatility of the chlorides at a given temperature. This process may be applied to the determination of vanadium in rocks and ores.

The method comprises two operations: the extraction of the vanadium as a vanadic solution, and its volumetric or gravimetric determination.

To isolate the vanadium, dry chlorine is passed over an intimate mixture of 4 parts of the sample and 1 part of charcoal, contained in a tube heated to 250° in a special furnace. In case of ores which are almost always arseniferous, the mixture must be previously made into a paste with oil, and calcined at a red heat. When operating upon rocks this precaution is needless. Schlœsing's apparatus is used for generating chlorine.

The tube containing the mixture is connected to a system of condensers, formed of two Mohr's bulb-tubes. As vanadyle chloride in presence of water forms vanadic acid, the presence of vanadium is indicated by the formation of a red coating in that part of the first tube connected directly with the apparatus.

If there is only a very little vanadium in the rock examined, the liquid of the first bulb is not coloured. The vanadium may be detected by dissolving the condensed product in weak hydrochloric acid. The solution on evaporation gives a residue which, if moistened with a drop of colourless ammonium sulphide, takes the purple colour characteristic of vanadium sulphide.

The vanadium is determined by following Margueritte's method applied to the determination of small quantities of iron. We first prepare a standard solution of vanadic acid by dissolving pure vanadic acid in sulphuric acid; 10 c.c. of this liquid represent 0·0028 grm. of vanadium. Numerous experiments have proved that vanadium may be determined, like iron, by reducing the vanadic salt with zinc. The solution of permanganate used is $\frac{1}{1000}$. With such a dilution it is necessary to use certain precautions in order to seize the end of the reaction. The liquids must be hot, and distilled water must be used having no action upon permanganate. Common distilled water always decolourises dilute solutions of permanganate. It is obtained sufficiently pure by re-distilling it over permanganate crystals and preserving it from atmospheric dust.

When the quantity of vanadic acid is high, as in certain ores, the liquid in the first bulb turns a greenish blue. The acid solution, mixed with ammonia and evaporated to dryness, gives a residue which, if heated to redness, may be weighed as vanadic acid.—*Comptes Rendus* (civ., p. 990).

METHOD OF PREPARING ANHYDROUS METALLIC CHLORIDES.

By H. N. WARREN, Research Analyst.

The following method of preparing metallic chlorides differs from the old method of subjecting the oxide of the metal admixed with charcoal to a high temperature in covered crucibles, and avoids the difficulty of obtaining thereby an intimate mixture of the same:—

Petroleum oil is saturated with either chlorine or hydrochloric acid gas, both gases being soluble to a large extent, especially the hydrochloric acid gas. The temperature of the oil should be maintained as low as possible during the passage of the gas, in order to increase the solubility of the gas. The oxide of the metal, supposing it to be aluminium oxide, Al_2O_3, of which the chloride is desired, is introduced into large earthenware retorts provided with a tubulus, and raised to a red heat by means of a charcoal furnace. An apparatus containing the saturated petroleum is now connected with the tubulus of the retort, and sufficient heat applied to raise the oil in vapour. When this comes in contact with the ignited oxide a strong reaction at once commences, fumes of aluminium chloride are at once evolved, and distil over into a receiver placed for their reception; the reaction being maintained as long as any alumina remains in the retort, which may be easily ascertained when no white vapours of aluminium chloride appear in the receiver. A second quantity of ignited alumina is similarly introduced through the tubulus of the retort, and the action maintained as before. Several pounds of alumina may by this means, in a short time, be converted into aluminium chloride, and may be readily purified from any oil which may contaminate it by the application of a gentle heat: metallic bromides may be also readily obtained by introducing bromine in the place of chlorine. I have also used naphthaline chloride with advantage, as also chloride of carbon, but the high price of both render them absolutely unfit as commercial products when compared with rock oil.

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My invention relates to the manufacture of an illuminant appliance in the form of a cap or hood to be rendered incandescent by gas and other burners so as to enhance their illuminating power. For this purpose I employ a compound of oxide of lanthanum and zirconium, or of these with oxide of yttrium, which substances in a finely divided condition when they are heated by a flame give out a full, large, almost pure white light, without becoming volatilised or producing scale or ash, even after being kept incandescent for many hours, but remain efficient without deterioration even when they are long exposed to the air.

The proportions in which the substances are compounded may be varied within certain limits. I have found the following proportions very suitable:—

60 per cent zirconia or oxide of zirconium,
20 per cent oxide of lanthanum,
20 per cent oxide of yttrium.

The oxide of yttrium may be dispensed with, the composition being then—

50 per cent zirconia,
50 per cent oxide of lanthanum.

Instead of using the oxide of yttrium, ytterite earth, and instead of oxide of lanthanum, cerite earth containing no didymium, and but little cerium, may be employed.

For applying the substances mentioned as an illuminant I use a fine fabric, preferably of cotton previously cleansed by washing with hydrochloric acid. I saturate this fabric with an aqueous solution of nitrate or acetate of the oxides, and gently press it until it does not readily yield fluid, so that in stretching or opening out the fabric the fluid does not fill up its meshes. The fabric is then exposed to ammonia gas, and when it has been dried it is cut into strips and folded into plaits. One method of giving the desired shape to the cap or hood is to draw a fine platina wire through the meshes of the net and bend it to the form of a ring so as to give the fabric the shape of a tube, the edges of which are then sewn together with an impregnated thread. The cap or hood thus formed can be supported on cross wires in the chimney of the lamp. The platina wire ring may be attached to a somewhat stronger platina wire to form a supporting stem by which the net can be secured to a holder on the burner tube, the net itself being at such a height that the platina ring is an inch or more above the burner.

On igniting the flame the fabric is quickly reduced to ashes, the residuum of earthy matters nevertheless retaining the form of a cap or hood.

For part of the zirconia a mixture of magnesia and zirconia may be employed with a little loss of intensity of the light.

Obviously fabrics of various forms or constructions may be employed according to the character of burner to which they are applied.

In order to protect the fabric and prevent its rupture when it is exposed to a strong current of gas, stronger threads can be added to the fabric before it is converted into ashes. Also the fabric can be painted with or dipped into concentrated solution of the salts so as to provide a fresh layer of the metallic salts, which becomes fully oxidised soon after the fabric has become incandescent. In order to strengthen the connection of the cone of earths to the platinum wire, those parts of the fabric which are next the wire are more fully impregnated with the solution, or with a solution of about equal parts of nitrates of magnesium and aluminium.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

The manufacture substantially as herein described, of an illuminant appliance for gas and other burners, consisting of a cap or hood made of fabric impregnated with the substances mentioned and treated as set forth.

Complete Specification (A.D. 1886.—No. 3592).
Improvements in Illuminant Appliances for Burners.

In the Specification No. 15,286 of 1885 of Carl Auer von Welsbach is described the manufacture of illuminant appliance for burners, in the form of a cap or hood made by impregnating fabric with solutions of salts of certain rare metals and then by the heat of the flame consuming the fabric so that the skeleton remains consisting mostly of the oxides of the metals, which, heated to incandescence, gives out a brilliant light. The said Carl Auer von Welsbach, continuing his researches since filing the provisional specification No. 15,286 of 1885, has found that certain substances other than those mentioned therein can be advantageously employed in producing such illuminant appliances, and has communicated the present invention, which I will proceed to describe. For making an illuminant cap or hood to produce, when heated, a white light, the following substances may be used:—

1. Pure thorinum oxide makes a hood which is rigid when incandescent.

2. A mixture of thorinum oxide about 3 parts with 2 parts of magnesia makes a hood which is flexible when incandescent.

3. A mixture of thorinum oxide, zirconium oxide, and

yttrium oxide, in nearly equal proportions, gives a slightly yellow tint to the white light.

4. A mixture of thorinum oxide, zirconium oxide, and lanthanum oxide, in nearly equal proportions, the lanthanum a little in excess, gives a very brilliant light, and the hood is flexible when incandescent.

5. A mixture of thorinum oxide and lanthanum oxide in equal parts, with about half a part of magnesia, makes a hood which is flexible when incandescent.

6. A mixture of thorinum oxide about 3 parts with 1 of magnesia and 1 of alumina gives a hood which is very flexible when incandescent.

In the mixtures which include lanthanum oxide, for a portion of that substance yttrium oxide may be substituted.

When a yellow light is desired the mixture may be—

7. Thorinum oxide and lanthanum oxide in equal proportions.

For an orange light it may be—

8. Thorinum oxide and neodymium oxide in equal proportions. As the name neodymium is new it is necessary to explain that it is one of two metals constituting what is generally supposed to be a simple metal, didymium.

For a greenish light it may be—

9. Thorinum oxide and erbium oxide in equal proportions.

In the mixtures 7, 8, and 9, zirconium oxide may be substituted for a portion of the thorinum oxide. Though magnesia and alumina can be employed, as in 5 or 6, it is better to avoid the use of much of these substances, as hoods containing them are not so durable as those from which they are absent.

For impregnating the fabric, solutions of the salts of the metals are employed as described in the previous specification, but it is not necessary that all the substances should be in solution. Some of the salts in pulverulent amorphous or finely crystalline condition may be mixed with a solution of salts of the other metals so as to produce a thickish liquid in which the undissolved salt is suspended. With this liquid the fabric can be repeatedly soaked, surplus liquid being pressed out between the successive impregnations until there is uniform distribution of the substances over the fabric.

In preparing the solutions a number of different salts may be employed. Nitrates are generally soluble; so also, but in less degree, are the sulphates, chlorides, iodides, bromides; also some organic salts, such as acetates or formiates. Generally the fluorides, carbonates, hydroxides, and many of the organic salts are insoluble, or soluble with difficulty. Those products which are insoluble or only partially soluble may, however, be employed as above described, in admixture with solutions of soluble salts.

When the fabric has been thoroughly impregnated and dried, and formed into the desired hood shape, it is not necessary to treat it with ammonia as described in the former specification; it may at once be subjected to the action of heat, care being taken to apply the heat first to its upper part, and then gradually downwards, as may be done by lowering the burner flame within the hood or raising the hood. It is of advantage to strengthen the hood by drawing through it in various directions stronger threads, themselves impregnated with the illuminant substance, or fine platinum wires may be used. The hoods may be made as tubes, woven or knitted, some parts, especially the upper parts, being made stronger by using in these parts meshes of smaller size than the meshes generally, or by double weaving or knitting of the parts that require greater strength. Also the hood may consist of several thicknesses of fine open fabric, or of a single fabric pleated or folded; or, instead of using fabric, a number of separate impregnated threads may be hung from a ring of platinum wire so as to surround the flame. The attachment of the hood or threads to the suspending ring should be strengthened by serving the upper part before burning with a mixture of nitrates of the metals employed and magnesium nitrate. Usually the hood is protected by being enclosed within a glass chimney like that of an argand lamp, but when a chimney is not used it may be surrounded by a cage of fine platinum wire.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

In hoods prepared as illuminant appliances for burners, the use of oxide of thorinum alone or in admixture with oxides of zirconium, lanthanum, yttrium, neodymium, erbium, magnesium, or aluminium, substantially as herein described.

Complete Specification (A.D. 1886.—No. 9806).

Method of obtaining Compounds of the Rarer Metals from their Earths for Use as Incandescence Bodies for Illuminating Purposes.

This invention relates to the treatment of the earths of the rarer metals, such as minerals containing cerium, didymium, lanthanum, thorinum, and zirconium, in order to obtain therefrom solutions suitable for the production of incandescence bodies such as are described in the Specifications to Patents Nos. 15,286 of 1885 and 3592 of 1886.

In treating cerite, orthite, and other similar minerals containing cerium, didymium, and lanthanum, for obtaining these in a separated condition, the minerals are in the first instance heated to a red heat, with free admission of air in those cases in which iron is contained therein in the form of protoxide, in order to oxidise the iron of the cerite compounds to a higher degree, and thus avoid various difficulties in the subsequent operations. This heating process is, however, only applicable when the percentage of cerium compounds is considerable, and when the mineral is a silicate, and not fusible in ordinary temperatures. A number of such minerals comply with these conditions; in particular may be mentioned cerite, the treatment of which will now be described by way of example.

The raw material, as extracted from the earth, is heated to a red-heat in lumps about the size of a fist, with free admission of air, for about an hour.

The mineral is thereby changed in such manner that its original reddish grey colour has been converted into yellow, and that it has taken up oxygen. The lumps, while hot, are plunged rapidly into water, whereby they crumble to pieces, thus greatly facilitating the following disintegrating process in which the material is crushed partly to powder and partly into small particles of about the size of hemp-seed. The finer particles being separated from the coarser ones, both parts are stirred in suitable vessels together with ordinary concentrated hydrochloric acid, whereby the finer particles become decomposed under evolution of heat, while the coarser particles only become slightly heated. After some days the finer particles will be entirely decomposed, and if the proper proportion of acid has been used this will have become entirely exhausted.

The decomposition of the coarser particles takes place more slowly, and is only completed in about a fortnight. It is advantageous to draw off the lye formed after a few days, to levigate the sludge with water, and to mix it with a fresh supply of concentrated hydrochloric acid until all particles susceptible of decomposition are decomposed, which can be ascertained by the fact that the original grains of cerite will have been converted into a friable skeleton mass of silicic acid. The chloride solution obtained by the above process is precipitated by means of oxalic acid, and the oxalates are washed by decantation and through a filter-cloth, and after being pressed dry they are heated to a red heat in shallow iron pans, but only to such an extent that no complete conversion into the oxides is effected.

The brown oxides, containing a considerable amount of carbonic acid, should, on being treated in the cold with

concentrated nitric acid, dissolve after a short time, with ebullition, into a dark red liquid. Only when obtained in the above-described manner is the preparation suitable for the following separation process.

The oxides are now stirred together with water in a fire-clay vessel and heated on a steam-bath, nitric acid being added in small quantities until a frothing is observed to take place after every addition.

As the composition of the minerals is very variable, even when taken from one and the same locality, the quantity of nitric acid cannot be fixed in advance.

The nitrate solution formed after the addition of the nitric acid is digested with excess of the earths. If, after about ten hours digesting, it is not converted into a very fine yellowish red or yellowish powder, but remains of a brown colour, nitric acid must again be added, and this process must be continued until the precipitate shows the above-mentioned colour. The supernatant lye is then of an amethyst colour, and the precipitate formed is insoluble even in very dilute lye.

If, in carrying out the process, so much nitric acid has been added that the yellowish white precipitate is dissolved into a yellowish liquid on the addition of a large quantity of water, then too much acid has been added, and quantities of the earthy sludge, obtained as above described, mixed with water, must be added until the precipitate obtained has the above-mentioned properties.

In this precipitate will be contained the whole of the cerium of the original mineral in the form of a compound insoluble in water, while the lye will contain all the other rare earths.

The cerium precipitate obtained, after washing, is readily soluble in nitric acid when heated, and the dark red solution thus obtained is mainly cerium nitrate.

The principal constituents of the lye will be the elements of didymium (praseodymium and neodymium), and lanthanum.

For separating these from each other, the lye separated from the precipitate is evaporated and treated with nitric acid and ammonium nitrate, and is separated into its constituents by the formation of the ammonium double nitrates.

In order to perfectly separate the lanthanum by means of fractional crystallisation the crystallising process must be repeated several times.

The colourless crystals of lanthanum ammonium nitrate are chemically pure, and form as solution one of the principal ingredients of the liquid for producing the incandescence bodies.

In treating zirconium this is reduced to about the size of peas, heated to a white heat under free admission of air, pulverised, and levigated, and is then digested for several days with concentrated pure hydrochloric acid, for the purpose of removing all traces of iron. The original brownish grey powder is by this means converted into a perfectly white powder, and many of the impurities originally contained in the zirconium crystals are dissolved. The fine zirconium powder is then washed and dried, and is mixed with double the quantity of calcined carbonate of soda, and, after being ground fine, it is subjected to a white heat for about three hours in a platinum crucible. The cakes of soda melt thus obtained are placed in cold clean water, when a fine white powder will be precipitated, while numerous bodies that are not useful for the purposes of the invention pass into the mother-liquor. The white powder is washed in water, dried, and treated with sulphuric acid under trituration until a sample heated on platinum clearly shows an excess of sulphuric acid.

The decomposition of the white powder by sulphuric acid takes place under considerable heating, and care must be taken that the acid is very gradually added (the powder remaining perfectly dry), as otherwise a scattering of the mass will ensue. The powder is then heated to the boiling-point of the sulphuric acid, whereby the greater part of the excess of acid will be driven off. After cooling, the powder is mixed with a large quantity of cold water under stirring, whereby the zirconium will be dissolved as sulphate, together with other bodies. The undissolved precipitate is unconverted zirconium and silicic acid. This is separated by filtration and washed.

The before-mentioned solution of zirconium sulphate is precipitated by ammonia in the cold, and is washed. If this material be now dissolved in nitric acid, so that no considerable excess of acid occurs, a brilliant white powder will after a short time be precipitated, which is a peculiar combination of zirconium, containing this metal in an almost chemically pure condition. The impurities, such as iron, alumina, &c., remain in the lye. This reaction is based on the fact that a small quantity of sulphate of ammonia present in a solution of nitrate of zirconium effects the separation of the before-mentioned compound, completely so when heated, and partially when cold. As an excess of sulphate of ammonia dissolves the zirconium precipitate, this is to be avoided.

The precipitate containing the zirconium is almost quite insoluble in water, but soluble in nitric acid when freshly precipitated; when digested with ammonia it is rapidly converted into dense zirconium hydroxide, which is readily separated by washing. This body is then dissolved in concentrated nitric acid, and the solution is evaporated on a water-bath, producing clear gum-like crusts consisting of zirconium nitrate.

This substance dissolved in water forms a second main constituent of the incandescence body.

The presence of small quantities of iron, such as are contained in the preparation of zirconium heretofore made, is very detrimental to the action of the incandescence body.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is—

1. The method substantially as herein described of treating cerite, orthite, and similar minerals containing cerium, didymium, and lanthanum, with hydrochloric acid in the cold, for effecting the separation of the said metals.

2. The method substantially as herein described of separating the cerium from the minerals referred to in the preceding claim, by treating the chloride solutions thereof with oxalic acid, heating the oxalates obtained to redness, and treating the resulting oxides with nitric acid, whereby the cerium is obtained in the form of a nitrate solution.

3. In combination with the method for the separation of cerium from minerals containing cerium, didymium, and lanthanum, referred to in the preceding claim, the separation of the didymium and lanthanum contained in the lye after separation of the cerium, by evaporating the lye, and treating the residue with nitric acid and ammonium nitrate, whereby ammonium double nitrates of the said metals are obtained in the form of crystals, substantially as herein described.

4. The method substantially as herein described of treating zirconium for the removal of all traces of iron therefrom, consisting in first heating the zirconium to a white heat under free admission of air, and then, after finely pulverising the same, treating it for several days with hydrochloric acid.

5. The method substantially as herein described of producing zirconium in a form suitable for an incandescence body, by first converting the zirconium into a sulphate, and, after treating with ammonia, dissolving the same in nitric acid, thereby obtaining a precipitate which, when digested with ammonia and dissolved in nitric acid and evaporated, produces zirconium nitrate.

6. The method substantially as herein described of separating a zirconium compound from a solution of zirconium in nitric acid by means of sulphate of ammonia, whether this be present in the solution from previous processes or be subsequently added.

THE HARDNESS OF METALS.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S.,
Lecturer on Metallurgy, Mason College, Birmingham.

(Continued from p. 182.)

Part II.

Reference has been made to Moh's scale of hardness commonly used by mineralogists. In spite of its great usefulness as a ready means of classification, it possesses imperfections which have long been recognised, and many attempts have been made to remedy these. One of the most successful and accurate of these attempts is represented by the sclerometer, which appears to have been first used in Germany in 1883, by Seebeck, in a study of the hardness of calc spar and gypsum. His results were published in the "Programm des Berlinischen Real gymnasium," his conclusion being that the hardness of gypsum was the same in all directions on the same face of the crystal, while that of calcite varied according to the angle at which the crystal was examined.

The subject was afterwards more completely examined by Franz, in 1850 (*Pogg. Ann.*, lxxx., p. 37), which is the earliest paper on the subject to which I have access. The apparatus itself, which is figured in the original paper, practically consisted of a diamond or steel point, balanced at the end of a beam, and upon which, by means of a small table, any desired weight could be placed. The specimen to be examined was fixed in a revolving table underneath the point, and the weight was gradually increased until a visible scratch was produced on drawing the crystal under the weighted point. Franz concluded that the hardness of a crystal was greatest in the direction of cleavage, and least in a direction at right angles to this. His average results are as follows:—

Crystal.	Moh's Scale.	Weight in Grammes. Steel Point.	Diamond.
Gypsum	1·5	1·5	—
Calcite	3	9	—
Fluor-spar	4	36	—
Dioptase	5	115	—
Apatite	5	163	12
Diopside	5—6	205	—
Felspar	6	260	20
Pistazite	6—7	—	24
Quartz	7	—	34
Zircon	7·5	—	38·5
Tourmaline	7—7·5	—	39·5
Beryl	7·5—8	—	43
Topaz	8	—	43
Sapphire	9	—	51

It will be seen from the above table that with soft minerals Franz employed a steel point, while for hard minerals the diamond was used. The values obtained agree very closely indeed with what might be anticipated from Moh's scale, and in this respect form a striking contrast with some other forms of apparatus previously described.

Since the experiments of Seebeck and Franz the sclerometer has been used by a number of observers, though its application appears to have been almost entirely confined to Germany. Recently an important modification has been introduced by Pfaff,† who draws a weighted diamond a definite number of times over the surface of the crystal to be examined, and weighs the specimen before and after the experiment. From the loss of weight and the known density of the material the depth of the grooves can be calculated, and Pfaff states that the hardness varies inversely as the depth of the groove. (*München Ber.*, 1883, pp. 55, 372; 1884, p. 255, more readily accessible as abstracts. *Neues Jahrb. f. Mineral*, 1884, ii., p. 4. *Beiblätter*, 1884, p. 278; 1885, p. 82). This method was used for gypsum, calc spar, and other soft minerals, for which it appears to be specially suited. I believe the results obtained by such a method would correctly indicate hardness if the precaution be taken only to remove the mineral in the form of very fine powder. If, however, sufficient pressure were applied to remove definite shavings or cuttings of the material then tenacity would interfere. The use of a diamond cutter in this manner is not admissible, however, in the case of soft metals; for while the diamond will cut the hardest hardened steel freely, it will not remove a cut from annealed steel or iron, or other soft metals, owing to the material clinging tenaciously and dragging under the treatment (G. Jones, *The Engineer*, lxii., p. 426). This method not being suitable for hard minerals, Pfaff adopted another system in such cases, the principle of which had already been applied by Bottone. A weighted diamond-borer was caused to rotate a given number of times, the depth to which it penetrated being measured by an ingenious lever indicator. The depth of the hole varies inversely as the mean hardness of the crystal. Though it appears to be extremely difficult to suggest a method of determining the mean hardness of a mineral, which should be open to less objection than that just described, still it may be pointed out that it is by no means perfect. As has been previously shown, if cuttings of any considerable magnitude were taken then the tenacity of the substance would have an important influence; further, in cases where marked plasticity was possessed this would introduce some error, while if the hole were not kept constantly clear of turnings a considerable amount of force might be expended on merely grinding these to powder.

The various methods employed for the determination of hardness by the mineralogists have been treated at somewhat considerable length, partly with the object of showing the methods we have at our disposal, and partly because the instrument I have employed is in reality only a modification of that originally described by Seebeck, and used by Franz over thirty years ago. My apparatus was constructed for use with cast-iron, but it has since been applied to a number of other substances.

Hitherto there have been few accurate observations of of the hardness of iron and steel. The workman judges of this character by the facility with which the iron can be drilled, turned, or filed, the hardest metal producing most sound, and yielding the smallest quantity of turnings or filings when worked. Such observations are of course only qualitative. The earliest attempt to give a quantitative value to hardness tests is represented by the work of the American experimenters to which reference was made (p. 180). Their method depended upon the production of a measurable indentation by means of a weighted punch, and the objections to such a system have been already mentioned. Doubtless the results obtained were of practical value, but they did not accurately represent the hardness of the metal. Two other methods depending upon similar principles have quite recently been brought under my notice.

1. Mr. G. A. A. Middleberg, of Amsterdam, writes to *Engineering*, 1886, ii., p. 481, as follows:—

"For many years I have used the following apparatus to ascertain the relative hardness of railway tyres, &c., and I find that it gives accurate and satisfactory results:—

A knife, *a* (see sketch), of hardened steel ¾ in. long with curved edge is pressed by lever and weight, *b*, on the surface of the metal, leaving there a line of a certain length, proportionate to the hardness of the metal. The range of the impression is about $\frac{1}{4}$ in. for copper and $\frac{1}{16}$ in. for hardened steel, and may be accurately measured. For softer metals a lighter weight, *b*, might be chosen."

The practical value of such observations for certain purposes cannot be doubted, but it will be seen that any such apparatus must fail to give accurate values for true hardness. Obviously with two samples of equal hardness, but differing in tenacity, a deeper indentation would be made in the less tenacious metal.

* Read before the Birmingham Philosophical Society, Dec. 9, 1886.
† I regret to learn, from Mr. Brough, that Mr. Pfaff has died since the above was written.

2. The following method has been communicated to me by Mr. Keep, of the Michigan Stove Company, Detroit, and from the tone of Mr. Keep's letter I conclude he would have no objection to my using the information it contained. A steel head half-an-inch in square section was prepared, and carefully divided into 100 pyramids, each as nearly alike and as sharp as possible. The head was attached to a bar arranged to move easily and accurately by means of guides. The test piece was prepared by grinding its sides as nearly parallel and as smooth as possible. It was then arranged in such a manner that only a corner point of the tool rested on the prepared surface, and so that when one row of points had left its mark the next row just began to act. The tool was pressed on the metal by means of a swinging weight of 25 lbs., which was allowed to fall one inch. The number of marks produced was then counted by means of a lens, while a light streamed across the surface. This method is very ingenious, but was not found to be very satisfactory. In some cases with iron, and especially with brass and copper, the whole surface was depressed instead of small indentations being produced. Mr. Keep also states that the number of marks does not vary as the force employed. Other objections will suggest themselves.

I have previously shown that hardness and tenacity are distinct physical properties, and that methods depending

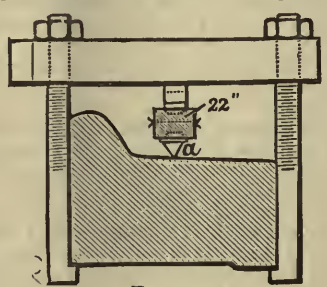


Fig. 1.

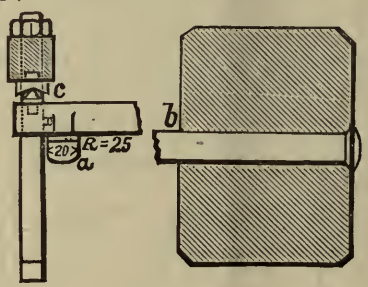


Fig. 2.

on the production of indentations or the use of cutting tools fail, at least in some measure, to distinguish between these two properties. It therefore becomes of interest to enquire what form of experiment is most likely to yield accurate results.

Theoretically, hardness is measured by the force necessary to separate the smallest particles or molecules of the substance, as distinct from tenacity, which is measured by the force necessary to separate the aggregated molecules, or the mass as a whole. Hence hardness is just overcome when abrasion begins, and can be accurately measured if the force necessary to produce abrasion is determined. In the use of cutting instruments the results become less and less accurate expressions of hardness as the thickness of the turnings increases, and hence the methods employed by Pfaff only yield correct results when indefinitely small portions of the material are removed at each operation. Theoretically, therefore, the best method is to determine the force necessary to just produce an abrasion with a tool of a given size and shape; while practically this becomes a point to which a given force is applied. This method, however, though theoretically the most perfect, possesses an inherent difficulty, owing to the uncertainty as to the moment at which abrasion commences.

In connection with the subject of abrasion, Professor R. H. Smith, of Mason College, allows me to mention a method adopted in his laboratory, some time ago, for the examination of the effect of tempering on the hardness of steel. The specimen to be tested was first carefully weighed, and then pressed with a definite force against a revolving grindstone or emery wheel, the number of rotations of which was observed. In using an emery wheel sufficient water was made to flow over the specimen to prevent any considerable rise of temperature. The loss of weight of the specimen at the end of the experiment gave an indication of the hardness of the metal. It will be seen that the material is removed by means of abrasion, and hence the method is, in this respect, superior to those previously mentioned. I am, however, unaware how far results obtained in this manner agree with those given by other forms of experiment. But such a method is only suitable for hard substances, for, as pointed out by Gavin Jones (*Engineer*, lxii., 426), emery wheels, especially in dry grinding, will grind hardened steel freely, but will scarcely act on soft steel or iron, much less on copper. The hardened steel cuts with a crisp feel under the emery wheel, whereas the softer metals cling tenaciously and drag under the treatment, the particles yielding slowly, and being torn off with great force rather than cut.

My own original apparatus consisted merely of a balanced lath, capable of motion in a horizontal plane. Through one end of the lath, at right angles to its length, passed a cutting diamond, arranged so that it could be weighted as necessary. The weighted diamond point was drawn over the smooth surface of the metal to be tested, while the weight necessary to produce a visible scratch was observed; the weights were then diminished until no scratch was visible on again drawing the diamond over the metallic surface. The mean of these observations was taken as the measure of relative hardness. The results are given in Table B, and will be again referred to. It will be sufficient now to say that the values obtained with this simple apparatus agree closely with those afterwards obtained in similar experiments with a more perfect instrument and another diamond. Further, I have recently tested the specimen containing 2 per cent of silicon with my newest apparatus, and obtained a hardness of 21, as against 22 with the same specimen and my first arrangement.

(To be continued).

THE ROYAL JUBILEE EXHIBITION, MANCHESTER.

The first Industrial Exhibition which has ever been held in Manchester promises, from the advanced state of preparation in which it now is, to satisfy the hopes of the most sanguine of its promoters. The general object and scope of the Exhibition will be to illustrate, as fully as possible, the progress made in the development of arts and manufactures during the Victorian era. The principal sections into which it is divided are—Industrial Design; Machinery and Engineering Plant, &c.; Chemical and Allied Industries; Electric Light, &c.

The Chemical Section is very well illustrated, and occupies the chief portion of the south of the main building, covering a space of 700 ft. × 60 ft. It is subdivided into fifteen groups, besides a special Sub-section which is devoted to Photography, an art which is essentially a product of the Victorian era, the whole of its history being comprised within that period. The first exhibits which

catch the eye on entering the Chemical Section are those of Messrs. Bailey and Co., of Salford, and Messrs. Doulton and Co., of Lambeth, both of whom make a good show of the appliances and apparatus for which they are each celebrated. A few yards further along we note a new instrument invented by Mr. J. W. Lovibond, called the Tintometer: by its means the depth of colour in liquids, and even solids, can be accurately measured in degrees, and placed in their position in a colour-scale. The instrument consists of two tubes, 18 inches long, side by side, open at the ends. In one tube is placed the liquid to be examined, and in the other a series of coloured glasses with which the comparison is to be made: both these tubes are observed through a single eyepiece. The standard scale of colour is formed of a series of glasses, of various known tints and depth of colour, all having a certain proportion to each other. It can be easily seen that when once the colour of any solution has been ascertained, a record can be kept, and the same shade reproduced at any time for comparison.

The Harden Star and Sinclair Fire Appliance Company, Limited, show a general assortment of fire appliances, including hand fire grenades, automatic sprinklers, &c. The new light known by the name of Lucigen is also exhibited by this firm. The light, which is an exceedingly powerful and at the same time mellow one, is produced by burning creosote, tar oil, or other heavy hydrocarbon, in a special burner, by means of compressed air. The action of the compressed air is to form the oil into an extremely fine spray, and in this condition it is burnt, giving off no smoke or smell. It is claimed for this light that it will burn equally well in the wind and rain, and requires no lantern.

Otto Wolters shows an assortment of assay, chemical, and bullion balances, including his improved short-beamed analytical balances. A very good collection of theodolites, anemometers, levels, pressure and vacuum-gauges, thermometers, &c., is shown by J. Casartelli, of Manchester.

Messrs. Mottershead and Co. exhibit a complete set of chemical and physical apparatus for private laboratories, schools, &c., as well as fine chemicals for use in medicine and the arts, peptonised foods, &c.

Plant for bleaching cotton, linen, &c., by the Blanchine process, which dispenses with the use of lime, and samples of cloth that have been so bleached and afterwards dyed, are shown by the East Lancashire Chemical Company.

The British Alizarine Company, Limited, have a very good case of anthracene derivatives, such as alizarine, anthro purpurin, and flavo-purpurin, employed in the dyeing and printing of cotton and woollen fabrics, and specimens illustrating the various stages of the manufacture of these products.

Amongst the exhibits of Chemical Research are the cases of Sir Henry Roscoe, M.P., containing a collection of pure vanadium and tungsten, with compounds of those rare metals; that of Edward Schunck, Esq., F.R.S., who exhibits a complete collection illustrative of his researches on the principles contained in madder, constituents of natural indigo, &c.; and lastly, that of Dr. W. H. Perkin, F.R.S., who exhibits specimens illustrating his discovery of the first coal-tar colour,—mauve,—which was the commencement of the now important coal-tar colour industry. Some of the most interesting specimens are those of mauve, as first made in 1858; para-saffranine, as first obtained by oxidising mauveine; coumarin, the odoriferous principle of the Tonka bean; cinnamic acid, and others,—all first prepared artificially by Dr. Perkin.

Messrs. Hardman and Co. show a model of the plant required in the manufacture of some of the useful products from residuals obtained in the manufacture of coal-gas. The specimens include crude and purified products obtained from coal-tar, ammoniacal liquid, and spent oxide.

There is a good collection of pigments, paints, &c., among which we may mention the exhibit of Wm. Pakeman and Co., of colours for calico-printers, paper-stainers, printers, &c., all free from arsenic, and that of Wm. Taylor and Co., Limited. A novelty in the way of paint, is that exhibited by Mr. Henry Crookes, called Heat-Indicating Paint, from its property of changing from a bright red to a dark brown colour when heated up to 140° F., and resuming its original colour on cooling; this property renders it very useful to engineers and others for showing the temperature of bearings or other surfaces liable to be overheated. One of the most important improvements in paint making within the last few years is that of Messrs. J. B. Freeman and Co., who exhibit their non-poisonous white-lead; all who have had experience of domestic painting will appreciate such an improvement as the use of this will be. It is entirely free from smell and perfectly harmless to the workmen in all stages of its use and manufacture; it is not darkened by sulphuretted hydrogen, which is another great advantage in this country. The basis of this paint is sulphate of lead, but it is prepared in such a manner that its character is quite changed; it is no longer "slimy," when mixed with oil, and possesses great density and opacity, while its whiteness is greater than that of the finest white-lead made by the Dutch process.

The Select Exhibit of the Committee of Section III., collected by Mr. Watson Smith, is of extreme interest, comprising the MSS. and Relics of Dr. John Dalton, the propounder of the atomic theory, Sir Humphry Davy's chemical balance, &c. Specimens of American and Russian petroleums, also of crude anthracene obtained by passing Russian petroleum residues through red-hot tubes. A parti-coloured flag, showing the exact amount of dyeing power in one pound of Manchester gas coal. Specimens of raw jute fibres, cottons, barks, resins, and many others, illustrating a large number of important industries.

Group VI. comprises fine chemicals, alkaloids, extracts, &c., the principal exhibitors being James Woolley and Sons, Grimshaw Bros., Howards and Sons., and Kay Bros.

In the Metallurgical Group Messrs. Henry Wiggin and Co. exhibit specimens of nickel and cobalt ores, and materials showing the process of manufacture from the native mineral to the finished article.

The Cowles Electric Smelting and Aluminium Co. show sample ingots of the products of the electric smelting furnace, and Cowles process of manufacturing metallic aluminium.

Messrs. Peter Spence and Sons show the largest crystal of alum ever made; it is about 6 feet in diameter and 12 feet high and of the finest quality. They also show many other specimens of alums and compounds of alumina used by paper makers and dyers.

The Sub-section of Photography is of great interest, containing specimens of photographs obtained by all the known methods. An enlarged copy of a photograph of the great nebula in Orion, taken by A. A. Common, Esq., and a collection of astronomical photographs taken by MM. Henry Paul and Prosper at the Paris Observatory, are specially interesting.

The Irish section contains a collection of scientific apparatus exhibited by G. F. Fitzgerald, Esq., comprising the late Dr. Lloyd's apparatus for exhibiting conical refraction. A model illustrating the electro-magnetic and luminous properties of the ether, and others.

Messrs. Yates and Sons show an optical bench and other optical instruments.

But the most important exhibit of scientific instruments in the whole building is undoubtedly that of Mr. Howard Grubb, F.R.S., comprising as it does such a large number of astronomical instruments; among these are two new forms of telescopes as constructed for Dr. Huggins and Mr. J. Roberts; the latter carrying an 8-inch refractor for general micrometrical work, and a 17-inch reflector especially fitted for steller photography; a new form of binocular telescope, by which means any size telescope can be used as binoculars, instead of as formerly the size

being limited by the distance between the human eyes; models of the great Vienna Equatorial, and of a design for the Lick Observatory, California, all the motions of which are to be worked by electricity; Microscopes, spectroscopes, and many other instruments, too numerous to detail.

The other sections of this Exhibition, which we may call the unscientific sections, are equally, and perhaps to many people more interesting, and we can only hope that a complete success will reward the labours of the Committees to whom the organisation has been entrusted.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, April 21st, 1887.

Mr. William Crookes, F.R.S., President, in the Chair.

Mr. T. H. Redwood was admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Ernest Francis Ehrhardt, B.Sc., Hillcrest, Richmond Hill Road, Edgbaston; Henry Hewetson McMinnes, Agricultural College, Roseworthy, Adelaide, South Australia; John William Young, B.A., Guilford Lodge, Brentwood.

The following were elected Fellows of the Society:—Messrs. W. C. T. Beasley; Edward R. Blundstone, B.A.; Samuel F. Burford; James W. Chenhall; George Collar, B.A.; Henry Danber, jun.; Hugh Gordon; William Gregory; David Lloyd Howard; Edward Rawlins; Louis H. Schubert; Leonard O. Simmons; Samuel Sutcliffe.

The following papers were read:—

37. "*The Atomic Weight of Gold.*" By T. E. Thorpe, F.R.S., and A. P. Laurie, B.A.

Former determinations of the atomic weight of gold have been made by Dalton, Proust, and Oberkampf, in 1806; Berzelius, in 1813; Pelletier, Javal, and again by Berzelius, in 1844; by Levol, in 1850; and Thomsen, in 1876. The numbers obtained differ widely from each other, partly owing to the unstable character of the salts of gold, and partly to imperfect methods of analysis. The number usually accepted is 196·2, being the value obtained by Berzelius in his second series of determinations, from the analysis of the double chloride of gold and potassium. A special reason for undertaking a revision of the atomic weight of gold arises from the circumstance that a higher value than that usually assigned to this element is demanded by the periodic law.

The salt employed by the authors is the bromide of gold and potassium, which crystallises readily from water, and (as proved by a series of analyses of different crystallisations) is stable at ordinary temperatures. The salt was prepared by digesting together gold, water, bromide, and potassium bromide, and was then three times crystallised.

The method of analysis was as follows:—

About 15 grms. of the double salt was introduced into a large porcelain crucible, carefully dried in an air-bath, and then decomposed by heating over a Bunsen flame. The crucible containing the mass of decomposed salt was weighed against a similar and similarly treated crucible, the bromide of potassium washed out with hot water, the solution being drawn into a bottle by reverse filtration, and the gold ignited in a muffle, and again weighed. From these weighings the first set of values for the atomic weight was calculated. A weighed quantity of silver (the purity of which had been tested at the Mint by comparison with the trial plate) was dissolved in dilute nitric acid and added to the potassium bromide, and the excess of the potassium bromide precipitated by a solution of silver nitrate of known strength. From these results the second series of values was calculated. The silver bromide was then collected, dried at 160° C., and weighed. From these weighings a third series of values was calculated.

On comparing the weight of silver used with the weight of bromide of silver obtained, the ratio between them was found to be Ag : AgBr = 1 : 1·74072. According to Marignac, Ag : AgBr = 1 : 74077. According to Stas, Ag : AgBr = 1 : 1·74081. The close agreement of these ratios with that obtained by the authors is a proof of the absence of chlorine in the bromine or potassium bromide employed by them in the formation of the double salt.

The ratios assumed between Ag, Br, K, O, and H were those of Stas and are as follows:—

Ag	6·7449
Br	4·99634
K	2·44523
O	1
H	0·06265

On the basis of these numbers, the results of the various observations may be thus summarised:—

Series I. (8 *Experiments*).

Au : KBr	37·49137 : 22·61944
„	1·65748 : 1
Au : O..	12·3343
Au : H	196 876

Series II. (9 *Experiments*).

Au : Ag	41·67403 : 22·79374
„	1·82831 : 1
Au : O..	12·3318
Au : H	196·837

Series III. (8 *Experiments*).

Au : AgBr	36·50997 : 34·76060
„	1·05033 : 1
Au : O..	12·3322
Au : H	196·842

On the assumption that these values have equal weight, the final value from the whole 25 experiments becomes—

		Diff. from mean.
Series I... ..	196·876	+0·026
„ II... ..	196·837	−0·013
„ III... ..	196·842	−0·008
Mean ..	196·850	

When a considerable portion of the determinative work connected with this investigation had been accomplished, a paper on the same subject appeared in the *Berichte* for February, 1887, by Krüss. Krüss also used potassium bromanurate, but his method of treating the salt differed somewhat from our. The following table contains a summary of his results:—

	Au (H=1).
I. Au : KBr,Br_3 (9 experiments) ..	196·741
II. Au : Br_4 (5 experiments)	196 743
III. Au : Br_3 (4 „)	196·619
IV. Au : KBr (4 experiments)	196·620

He also analysed a neutral solution of auric chloride, obtaining the value Au = 196·594.

He adopts as the most probable value Au = 196·64.

Discussion.

The President, after referring to the great value of such investigations, said that he should have been glad to have heard more from the authors regarding their method of weighing, and of the means they had adopted to control the accuracy of their weights, and to correct for the buoyant effect of the air; the errors incidental to the operations of weighing were often greater than the minute errors involved in the chemical operations. The quantities

of material used in the various experiments appeared to him to be very small: nevertheless the agreement between the results of the several experiments was highly remarkable.

Professor Thorpe, in reply, said that they had endeavoured to eliminate the corrections necessary on account of buoyancy, and of changes due to deposition of films of moisture, &c., by always using as a tare to the apparatus weighed a precisely similar apparatus which had been treated in the same way. The argument that the same result would have been obtained by means of a single experiment by taking the aggregate amount of salt used in all the experiments together presupposed that the errors of a series of experiments were all in one direction; but this was not the case.

38. "*The Atomic Weight of Silicon.*" By T. E. Thorpe, F.R.S., and J. W. Young, B.A.

The authors have attempted to redetermine the atomic weight of silicon by estimating the quantity of silica yielded by decomposing known weights of silicon tetrabromide by means of water. The results of their experiments are seen in the following table:—

Wt. of $SiBr_4$ *in vacuo.*	Wt. of SiO_2 *in vacuo.*	Si (H=1).
9·63007 grms.	1·67070 grms.	28·347
12·36099	2·14318	28·303
12 98336	2·25244	28·347
9·02269	1·56542	28·352
15·38426	2·66518	28·243
9·74550	1·69020	28·325
6·19159	1·07536	28·429
9·51204	1·65065	28·366
10·69317	1·85555	28·364

The aggregate weight of the silicon tetrabromide employed in the various experiments was 95·52367 grms.; it yielded 16·56868 grms. silicon dioxide. Assuming with Lother Meyer and Seubert that the most probable ratios for the atomic weights involved in the calculations are —

Br	4·99721
O	1
H	0·06265

the above numbers give as the atomic weight of silicon 28·332 if H = 1.

The previously recorded values are all based upon the ratios of equivalent quantities of silicon tetrachloride, silver, and silver chloride, and were obtained by using comparatively small quantities, *i.e.*, 1 to 2 grms. of the chloride. They are as follows:—

Date.	Authority.	Method.	No. of Expts.	Si(H=1).
1845..	Pelouze	$SiCl_4 : Ag$	2	28·41
1859..	Dumas	$SiCl_4 : Ag$	2	27·99
1861..	Schiel	$SiCl_4 : AgCl$	2	27·99

39. "*Note on Substitution in the Benzene Nucleus.*" By H. Forster Morley.

In an addendum to his paper on "An Explanation of the Laws which govern Substitution in the case of Benzenoid Compounds," Dr. Armstrong says that the formation of metanitro-derivatives on nitration of the sulphates of dimethylaniline, ethylaniline, and ethylpara-toluidine, while aniline and para-acetyltoluidine produced para- or ortho-derivatives, was due to an increase in the basic powers of nitrogen consequent on the introduction of hydrocarbon radicles in place of hydrogen, The experiments quoted admit, however, of a different explanation, those substances which are mentioned as giving meta-derivatives having been nitrated in presence of a large excess of ice-cold sulphuric acid, the others having been nitrated by a different method.

Dr. Armstrong's hypothesis, that meta-substitution is always preceded by combination of the reagent that produces substitution with the radicle already in the benzene nucleus, can hardly be maintained in face of such facts as that strong nitric acid converts dimethylaniline into a paranitro-derivative.

We know nothing concerning the cause of formation of meta-compounds; but only that when the group already present is highly chlorous, the new radicle, on entering, takes up the meta-position.

40. "*Reply to the Foregoing Note.*" By Henry E. Armstrong.

It is pointed out that Dr. Morley somewhat misrepresents the author's views. In order to make this clear, the formation of ortho- and para-derivatives is more fully discussed, and an explanation is given of the reasons which led him to think it probable that the behaviour of a compound like dimethylaniline would not in all cases be strictly in accordance with the para-ortho law. The author considers that Dr. Morley's statement, that "the group $N(SO_4H)H_3$ in aniline sulphate, &c., is more chlorous than NH_2, and hence gives rise to meta-derivatives," is a mere phrase; it in no way follows that such is the case, inasmuch as compounds containing the basic radicle NH_2, or allied groups, and those containing the chlorous radicles Cl, Br, &c., in most respects behave alike.

Discussion.

Mr. Groves, referring to the author's remarks on the action of sulphuric acid on aniline, said that when preparing sulphanilic acid he had been unable to find any intermediate product.

Prof. Meldola said that he had repeated many of Nölting and Collins's experiments, and that his results were entirely confirmatory of theirs. In preparing sulphanilic acid on a large scale no intermediate compound was formed, according to his experience.

Dr. Morley said that it appeared to him that the cases quoted by Dr. Armstrong did not serve to substantiate his view any more than those previously advanced.

Dr. Armstrong, replying to Mr. Groves, said that it was not to be expected that an intermediate product such as he had referred to would be noticed in preparing sulphanilic acid. As regards Dr. Morley's criticisms, it was most important to elicit opinions on the subject under discussion, and such criticisms were most welcome; but it was clear that Dr. Morley had failed to understand his views.

At the next meeting, on May 5th, the following papers will be read:—

"A Contribution to the Study of Well Waters," by R. Warington, F.R.S.

"The Influence of Temperature on the Heat of Dissolution of Salts in Water," by Prof. Tilden, F.R.S.

"Crystals in Basic Slag," by J. E. Stead and C. H. Ridsdale.

"The Distribution of Lead in the Brains of Two Factory Operatives Dying Suddenly," by A. Wynter Blyth.

PHYSICAL SOCIETY.

April 23rd, 1887.

Prof. W. G. Adams, Vice-President, in the Chair.

The following papers were read:—

"*On Delicate Calorimetrical Thermometers, and on Expansion of Thermometer Bulbs under Pressure.*" By Prof. Pickering.

The reading of a delicate mercurial thermometer, when placed in a bath at constant temperature, is found to depend on whether the thermometer was at a higher or lower temperature than the bath before immersion. Capillarity was suggested as an explanation, but experiment showed that the effect was not always greatest at the narrow parts of the tube, and hence this idea was discarded. By using the same tube with different bulbs attached the differences varied, and eventually the effect

was found to be caused by exposing the inside of the tube to air and moisture, for when bulbs were attached to new tubes without being so exposed the differences between the rising and falling readings disappear. Hence, for very delicate thermometers, great care should be taken not to expose the bore of the tube, and calibration of a tube before attaching the bulb must not be attempted. Even in the best tubes, after every possible precaution has been taken, the author finds some parts about which the mercury appears to stick, and in delicate observations these parts of the tube are to be avoided. He also finds it necessary to gently tap the top of the tube to relieve any friction, and has devised a clockwork arrangement for performing the operation uniformly.

In the second part of the paper the author describes the want of concordance between two thermometers which have been compared with the same standard, and finds it due to the expansion of the bulbs not being in all cases proportional to the difference of pressure between the inside and outside. Thermometers with large thin bulbs show greatest discrepancies, and the remedy is found to be in making the bulbs more rigid. This is done by having a double bulb, making them from cylindrical tube instead of by blowing, and increasing the thickness of the walls of the bulb. A knife-edge arrangement in the upper part of a thermometer is described, by which the same part of the graduated tube can be used whatever the temperature (about which small changes are to be observed) may be. The proper amount of the mercury column can be cut off with the greatest nicety by its use.

Mr. Whipple remarked that phenomena similar to those described in the paper were constantly coming under his notice, and mentioned the pressure corrections they were applying to thermometers used *in vacuo*, during some pendulum experiments at present being carried out. He also described the Kew method of determining the pressure correction in deep sea thermometers, which are protected by an outer glass jacket filled with alcohol.

Mr. Lant Carpenter described the first comparison experiments made at sea with protected and unprotected bulb thermometers.

In answer to questions, Prof. Pickering said the range of pressure used was from 0 to 3 atmospheres, and in his most delicate thermometer, where 200 m.m. correspond to 1° C., the difference between readings taken in horizontal and vertical positions amounts to 30 m.m.

"*Note on Magnetisation: on Sequences of Reversals.*" By R. H. M. Bosanquet, M.A.

Some experiments have recently been made on an iron bar whose magnetic properties under reversals with ascending values of current were first determined some years ago. The magnetic resistances have again been determined, first with ascending values of current, and afterwards with descending values. In all cases the induction was measured by reversing the current. The results, generally, show a greater magnetic resistance for descending values of current, except for small inductions, where the resistance was less, when the experiments were performed in the above order. The paper concludes with a molecular hypothesis to explain the above results.

"*On a Thermo-dynamical Relation.*" By Prof. Ramsay and Dr. S. Young.

The paper is an extension of one presented to the Society on Feb. 26, and of which an abstract was read by the secretary. The numerical results are given, from which the authors deduce the relation $p = b\,t = a$ for constant volume is deduced, and additional reasons are given for believing acetic acid (whose vapour density at ordinary temperatures is abnormal) to be a mixture of $C_2H_4O_2$ and $C_4H_8O_4$, the former preponderating as the temperature rises. The authors ask the society for a name to designate lines connecting pressure and temperature at constant volume, and for which they suggested "*isochors*" in their previous paper.

NOTICES OF BOOKS

Report of the Chemist to the New York Agricultural Experiment Station. By S. M. Babcock. Elmira, N.Y.: Advertiser Association. 1887.

The experimental work carried on in the chemical laboratory during the year 1886 has been principally a continuation of the study of milk and butter begun last year, and described in the last Report. A new viscometer has been constructed which promises to be of great assistance, as by its means certain important properties of milk and butter, hitherto unrecognised, can be investigated.

The apparatus used last year was similar in principle to the viscometers used for testing oils, but it was found to be of no good for testing milk, as the small quantities of solid matter present invariably clogged the opening of the pipette. Another instrument was therefore constructed, consisting of a heavy disc of metal supported in its axis by an elastic steel wire 0·2 m.m. diameter, the torsion of which causes the disc to oscillate when a rotatory motion is imparted to it; the lower end of the steel wire is rigidly attached to a hollow cylinder, open at both ends, which is immersed in the liquid to be heated. The damping effect of the liquids on the motion of the cylinder is a very sensitive measure of their viscosities. The upper surface of the disc is graduated, and a fixed pointer is placed directly above it, so that the degrees of oscillation can be easily observed.

The method of working out the results and plotting curves is very fully discussed, and several examples are given.

The testing of milk with this viscometer requires more care than when perfect solutions or simple liquids are examined. Unless a sample is thoroughly well mixed immediately before an estimation is made the result will not be trustworthy, on account of the cream separating and rising to the surface.

Several tables of the results of testing the milk of different cows are given, and it is found from them that a high coefficient for the fat and a low one for the serum is the most favourable for the economical production of butter. The influence of the viscosity of the milk serum in diminishing the efficiency of the churn has been confirmed by experiments in which viscous substances, such as gum, were added to the milk. A familiar illustration of the influence of viscosity in retarding the action of the churn is furnished by the ordinary method of preparing whipped cream, in which the formation of butter is prevented by adding a little gelatin to the cream.

The second part of this Report treats of the analysis of butters. Several samples of butter, from the Chicago Live Stock Show in 1885, were furnished for examination. The first test was for adulterations by several methods, the chief dependence being placed on Reichert's method of determining the volatile fatty acids. Microscopical examination was also made with a view to testing the value of Dr. Taylor's method, about which there was much difference of opinion. The results, however, were perfectly unsatisfactory. The crystals from all the butters, adulterated as well as genuine, giving a well-defined "St. Andrew's Cross" with polarised light.

Tables of analyses and other data then follow, and the methods of analysis employed are fully described.

In conclusion, we find the daily record of sunshine commenced in May, 1885, but, as these records extend only over two years, they do not yet give sufficient data from which any inference may be drawn.

Cantor Lectures.—The concluding course of Cantor Lectures at the Society of Arts will be on the "Chemistry of Substances taking part in Putrefaction and Antisepsis," by Mr. J. M. Thomson, on May 2, 9, 16, and 23. These lectures are intended to give a general account of the changes occurring during putrefaction, and will deal especially with the properties of the substances resulting from these changes. Special attention will be paid to the chemistry of the common substances employed as antiseptics.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 14, April 4, 1887.

Law of the Distribution of Rays and Bands Common to Several Band-spectra. Analogy with the Law of the Succession of Sounds of a Solid Body.—M. Deslandres.—This paper will be inserted at length.

Determination of Vanadic Acid.—A. Ditte.—This paper also will be inserted in full.

Chemical Function of Manganese and of some other Bodies in Steels.—O. Osmond.—During cooling manganese retards the molecular change of the iron, keeping the carbon in the dissolved state, and the iron in the condition β so much the longer as it is present in larger proportion. This action is strictly comparable to that produced upon a non-manganiferous steel containing the same amount of carbon by a more rapid cooling. In a word, it is equivalent to a more or less hard temper. Tungsten possesses the same properties in a more marked degree. Chrome does not appear to act upon the transformation of iron. Silicon is rarely met with in steels, unless accompanied by a greater quantity of manganese. Carbon remains the only steel generating body in the classical sense of the word; the other bodies introduced are merely modifiers.

Certain Ammoniacal Combinations of Cadmium Sulphate and Nitrate.—G. André.—The author gives the details of the preparation of these compounds, and indicates their analogies with the corresponding zinc and copper salts.

Detection and Determination of Vanadium in Rocks and Ores.—L. L'Hote.—(See p. 191).

A New Class of Ferro- and Ferri-cyanides.—J. A. Müller.—The new potassium ferrocyanide crystallises either in very thin scales or in rectangular tablets; 100 parts of water at 18 dissolve 148 parts of the crystalline salt. The solution is neutral to litmus and phenolphthalein, and presents the following reactions with solutions of metallic salts:—With cadmium chloride a milky white precipitate soluble in hydrochloric acid; with cobalt nitrate a peach-coloured precipitate which turns blue on heating and resumes its original colour on cooling; insoluble in hydrochloric acid; copper sulphate an apple-green precipitate; ammoniacal ferrous sulphate a white precipitate, turning blue on the addition of nitric acid; manganese chloride, a bulky white precipitate soluble in hydrochloric acid; ferric chloride a violet colour, and after a day or two a precipitate of the same colour; ammonium molybdate (dissolved in nitric acid), a canary yellow precipitate; gold chloride, a red-brown colour; uranium nitrate, a yellow precipitate verging on orange, insoluble in acetic acid, but soluble in ammonium acetate. The composition of this new ferrocyanide answers to the formula $FeK_3C_6N_5O+3\frac{1}{2}H_2O$, and may be interpreted by admitting the existence of a trivalent radicle, carbonyl ferrocyanogen. Chlorine converts this compound into a new ferricyanide, which gives with ferrous sulphate a blue precipitate, inclining to a violet.

Preparation of Propylamines and Isoamylamines.—H. Malbot.—This paper relates to the propylamines derived from normal propylic alcohol and to the isoamylamines derived from the amylic alchohol of fermentation. These alcohols, duly purified, were converted into hydrochloric ethers, which were then brought to a state of perfect purity. The ethers were then mixed with equal mols. of aqueous ammonia, and heated in closed vessels to 140° to 165° for twelve or twenty-four hours. The tubes were then found to contain two layers, the upper consisting of the secondary and tertiary amines.

On Terpinol.—G. Bouchardat and R. Voiry.—The authors conclude that the substance known as terpinol is a mixture. They have separated from it a compound which they name terpol, which forms five-sixths of the whole, and which is either identical or isomorphous with caoutchine monohydrate. The second product requires further examination.

The Octylic Ethers of the Mono-, Di-, and Trichloracetic Acids.—G. Gehring.—This paper does not admit of useful abridgment.

Detection of Sugar Glucose and Dextrine, added to Wines.—Tony Garcin.—The author determines the total reductive matter with the cuprotartaric liquid and determines the polarimetric deviation. If the proportion of reductive matter is 2 grms. or below, the wine is said to contain a foreign dextro-rotatory matter if its polarimetric deviation exceeds +13.

Bulletin de la Société Chimique de Paris. Vol. xlvii., No. 4, February 20, 1887.

Adulteration of Filter-Paper.—L. Padé.—The author has examined ordinary white filter-paper, and finds it to contain 10·4 per cent of total ash. Of this the proportion of calcium sulphate in two samples was found to be respectively 7·6 and 7·4 per cent. The author points out the serious errors and complications which such an impurity may occasion.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., March, 1887.

German Chemical Patents.—Preparation of Salols.—Hofmann and Schotensack.—C, No. 2052.

Preparation of Turpentines from the Resins of the Conifers.—Dr. Eugen Schaal.—S, No. 3991.

Preparation of the Ethers of the Fatty Acids.—W. Kirchmann.—K, No. 4729.

Preparation of Derivatives of Phenyl-methyl-oxyquinizine by the Reaction of Hydrazobenzol upon Ethyl-acetone-dicarbonic Ether.—No inventor's name.—G, No. 3697.

Preparation of the Ethylic Ether of a New Acid obtained with Ethylidendiamine and Acetylacetic Acid.—No inventor's name.—G, No. 3734.

Preparation of Oxyquinoleincarbonic Acids.—Dr. F. von Heyden.—H, No. 6336.

Improvement in the Preparation of Blue Sulphuretted Colouring-Matters.—Meister, Lucius, and Brüning.—F, No. 2855.

Preparation of Azo-colours by Means of a New Naphthol-disulphonic Acid.—Drs. O. Gurke and Ch. Rudolph.—G, No. 3636.

Preparation of Azo-colours by Means of the Diazo-Compounds of Diamido-diphenyl-acetone.—Dr. H. Wichelhaus.—W, No. 4260.

Yellow, Red, and Violet Colours prepared with the Tetrazo-derivative of α-Naphthylene-diamine.—No name.—B, No. 7157.

Process for Separating Crude Xylidine from its Isomers employed in Colour-making.—Dr. L. Limpach.—L, No. 3914.

Simplification of the Molybdic Method for the Determination of Phosphoric Acid.—A. von Reis.—Already noticed.

On Cyclamose.—G. Michaud.—From the Chemical News.

Analysis of Commercial Samples of Iodine.—G. Weiss.—From the Chemical News.

Commercial Analyses: Ferric Oxide and Alumina.—From the Chemical News.

Researches on Certain New Azo-Compounds.—Dr. Eugene Mentha.—The author has effected the synthesis of some novel azo-compounds, and especially of a monocarboxylated acid.

Disinfection by Heat.—From *Nature*.

A New Chemical Element.—A notice of germanium. Dr. Quesneville prefers for it Mendeleeff's name ekasilicium, and fears that the name germanium may be mistaken for geranium!

Academy of Medicine.—January 25, 1887.—A discussion—final it is to be hoped—on the use of salicylic acid for the preservation of foods and beverages. Its use was condemned by a very large majority.

Report presented by M. de Luynes on the Utilisation of Naphthaline in the Manufacture of Colouring Matters.—From the *Bulletin de la Société d'Encouragement*.

Chloride of Sulphur and its Use in the Vulcanisation of Caoutchouc.—Ch. A. Fawsett.—From the *Journal of the Society of Chemical Industry*.

New Process for the Production of the Alkaline Metals.—H. Y. Castner.—From the Chemical News.

Combustion of Glycerin by Chromic Acid.—MM. Cross and Bevan.

On the Same Subject.—Dr. Burghardt.—Both these papers are from the Chemical News.

Chemical Constitution of the Fruits of Daphnadium Cubeba.—J. O. Braithwaite and E. H. Farr.—From the *Pharmaceutical Journal*.

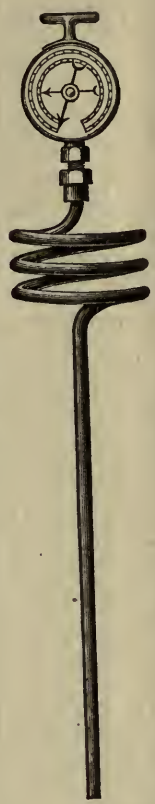
NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Watermark in Paper.—Will any correspondent please inform us as to the best method of putting in a water-mark or imitation water-mark into paper after manufacturing?—Midland, Wolverhampton.

MEETINGS FOR THE WEEK.

Monday, May 2nd.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "The Chemistry of Substances taking part in Putrefaction and Antisepsis," by J. M. Thomson, F.C.S.
—— Society of Chemical Industry, 8. "Recent Bacteriological Research in connection with Water Supply," by Dr. P. F. Frankland. "The Action of Zinc Chloride on Castor Oil," by Dr. C. R. A. Wright. "Pictet's Wood Pulp System," by Messrs. Cross and Bevan. "The Estimation of Moisture in Superphosphates and similar Fertilisers," by John Ruffle.
—— Royal Institution, 1.30. Annual Meeting.
Tuesday, 3rd.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "Electricity," by Prof. W. E. Ayrton, F.R.S.
Wednesday, 4th.—Society of Arts, 8. "Agricultural Education," by J. C. Morton.
Thursday, 5th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "The Chemistry of the Organic World," by Prof Dewar, F.R.S.
—— Chemical, 8. "A Contribution to the Study of Well Waters," by R. Warington. "The Influence of Temperature on the Heat of Dissolution of Salt Solutions," by Prof. Tilden, F.R.S. "The Distribution of Lead in the Brains of Two Lead Factory Operatives Dying Suddenly," by A. Wynter Blyth. "Crystals in Basic Converter Slag," by J. E. Stead and C. H. Ridsdale.
Friday, 6th.—Royal Institution, 9. "The Element of Truth in Popular Beliefs," by Dr. T. L. Brunton, F.R.S.
—— Geologists' Association 8.
Saturday, 7th.—Royal Institution, 3. "Recent Researches on Sponges," by R. Von Lendenfeld, Ph.D.



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THE CHEMICAL NEWS.

VOL. LV. No. 1432

ON PERBROMIC ACID.

By R. W. EMERSON MACIVOR, F.I.C., F.C.S., &c.,
Formerl Demonstrator of Chemistry, Anderson's College, Glasgow.

IN 1863 Kammerer (*Journ. Pr. Chem.*, xc., 190; *Bull. Soc. Chim.*, 1863, i., 129) announced that he had formed perbromic acid by the action of bromine on hydrated perchloric acid, and that from the acid so prepared had made the perbromates of potassium, barium, and silver. In 1874 M. M. P. Muir (*Chem. Soc. Journ.*, 1874) stated that he had succeeded in obtaining perchloric acid by Kammerer's method, and made brief reference to some perbromates which he had prepared from the acid. In 1876 (CHEMICAL NEWS, vol. xxxiii., p. 35) I proved that perbromic acid could not be formed in the manner described by Kammerer and Muir, and that therefore the salts which these chemists had described as perbromates were in reality only perchlorates.. Later in the same year Muir (*Journ. Chem. Soc.*, 1876) contradicted the assertions made in his first paper, and confirmed my results.

Since the publication of my note in 1876 I have at different times, and in different ways, tried to obtain perbromic acid from its chlorine analogue by the action of bromine, but without the least success. Bromine is without action on hydrated perchloric acid, anhydrous perchloric acid, and perbromate of silver, even when the substances are heated together in closed tubes.

TESTING AND REPORTING ON LUBRICATING OILS.

By THOMAS T. P. BRUCE WARREN.

I AM not aware that any one interested in lubricating oils pays much attention to professional reports. I am not myself surprised at this, because of the absence of data which will enable a user of these oils to know the relative merit of an oil in overcoming the friction arising from the movements of a shafting, which after all is the main point of interest to a user of lubricating oils.

Reduction of friction means a saving of coal and diminished wear and tear. From these considerations it follows that economy, as regards price per gallon, is a most unreliable line to follow. A manufacturer is mainly interested in reduced friction, and this friction is so easily compared that it becomes more surprising to meet with its omission so frequently in reports.

In comparing samples of machine oil, the very first test which I apply is to obtain a coefficient for friction. When the bearing has cooled, its condition is examined. It is quite possible that an oil may have so high a viscosity that it will not freely lubricate, and yet our professional reports attach great importance to this. If an oil is too thin, or becomes so by heat due to friction, it will run off a bearing, and so run to waste.

Again, an oil suited for a certain class of machinery may be unfitted for another. In a general factory the main point is to use, for any special machinery, that oil which experience alone can settle as being most beneficial, and to use a general machine oil which will suit the greatest number of bearings.

Defective bearings are sometimes met which will generate heat with one oil and not with another. I am not alluding here to bearings which are downright bad, but to such cases where a bearing is unaccountably critical in spite of engineering workmanship. Such a bearing as this will soon settle the special merits of a lubricator, for a machine oil which will work well on such a bearing will as a rule work well on any other.

An oil which will solidify or thicken at about 40° F., so as not to flow freely, may cause much mischief. A good lubricating oil for general use should be but slightly altered in viscosity between the temperatures of 40° F. and 70° F. Before petroleum lubricating oils came into use, lard oil was used for lubricating cylinders of engines,—the diminished viscosity due to high temperatures was not considered at all as productive of mischief.

Thickened engine oils are now commonly met with which do not flow freely even at 70° F. Such oils are generally produced by adding the tarry residuums obtained from vegetable oils with petroleum of high density, although petroleum oils of high viscosity are well known.

Petroleum oils do not act on brass or the alloys usually employed for bearings; the addition of thickened or slightly oxidised oil, so as to make a more viscid compound, is easily detected by placing a small quantity of the oil in a polished brass cup. If petroleum be not mixed with oil so thickened, its action on metals is only slight after some time; the unoxidised oils are decidedly free from acid, but as they become thickened by exposure their acid reaction is more strongly marked.

A drying oil, or an oil that thickens on exposure, is not regarded favourably as a lubricator, and I think this a matter which deserves more attention than is at present given to it. If such an oil were used by itself it would clog up; the addition of petroleum prevents this clogging by simply acting as a solvent of the oxidised oil; still after some long use such an oil will give trouble.

An engineer will always give preference to an oil free from this tendency to clog. Whenever a drying oil has been added to thicken a machine oil, its presence can always be detected by chloride of sulphur, as referred to in a previous communication.

Petroleum oils, if too thin, should be mixed with animal or fish oils. Purified rosin oil is largely used for lubricating, and, although manufacturers of machine oils condemn its use, I certainly am at a loss to understand upon what ground their objection is based. If a lubricating oil gives any sign of *gumming* up, when a bearing cools, resins, or similar body-giving substances, can be easily detected. Rosin oil does not produce this clogging if properly distilled.

The thickened oils which are used in compounding machine oils are rape oil, cotton-seed oil, and seed oils generally. A few years ago an oil was met with in commerce as "Seed oil." It is probably obtained from "Niger seed," and other unenumerated oil seeds which give the same reaction with chloride of sulphur, and consequently belong to the class of drying oils.

In a future communication I propose to give the analytical details for finding out the composition of a machine oil, and also the mechanical methods for determining the suitability of an oil for machinery.

DETERMINATION OF VANADIC ACID.

By M. A. DITTE.

THE process formerly indicated by Berzelius, the principle of which is the insolubility of ammonium vanadate in ammonium chloride, enables us to determine vanadium in the state of vanadic acid in an exact and relatively simple manner, but on condition of taking certain precautions which are indispensable if we wish to escape error.

Ammonium vanadate is at common temperatures insoluble in a saturated solution of ammonium chloride; if, therefore, we add ammonium chloride to the solution of

an alkaline vanadate, so as to saturate it, all the vanadic acid is precipitated in the form of a white crystalline powder, which is easily collected, and which is washed with a saturated solution of ammonium chloride; but when the washing has removed all foreign matter it is necessary to eliminate the sal-ammoniac in its turn, for if it remains mixed with the ammonium vanadate, or if the filter is still impregnated with it, it is volatilised on igniting the precipitate, reducing the vanadic acid and forming volatile compounds. We then see appear along the edges of the platinum capsule a blue colouration of the flame,—a certain sign that vanadium is being volatilised, and that the determination is inaccurate. The quantity of metal carried off may be considerable if the sal-ammoniac was mixed with the vanadate in a noteworthy proportion; but even if little of it remains it is plain that the same reaction is produced, and gives rise to losses of vanadic acid impossible to estimate.

It is therefore necessary to remove the ammonium chloride entirely, and this can be done by making use of alcohol; but this reagent, if poured upon a filter impregnated with a saturated solution of ammonium chloride, precipitates this latter upon the surface of the filter and even in its thickness, and this salt, sparingly soluble in alcohol, becomes difficult to remove. To use a mixture of water and alcohol is unsafe, for such a mixture—containing even 4 parts of alcohol to 1 part of water—dissolves a little of the vanadate unless it has been previously saturated with sal-ammoniac, which it is then incapable of dissolving. These inconveniences may be avoided in the following manner:—

1. Suppose the vanadic acid existing in solution as a pure alkaline salt. It must first be ascertained that the liquid is neutral or alkaline, for in an acid solution the ammonium vanadate is not completely precipitated. As every acid vanadate is more or less coloured, ammonia is added, and the liquid is heated until it is quite colourless. This decolouration would take place in the cold, but may take several hours. As soon as the temperature of the liquid has fallen to 30° or 40° we throw into it powdered ammonium chloride, little by little, and stir so as approximately to saturate it with this salt., and add to the solution 4 or 5 vols. of alcohol. It is then let stand for some hours, the ammonium chloride being sparingly soluble in this mixture. We have thus a saturated liquid in which the ammonium vanadate is insoluble. If the temperature of the aqueous solution did not exceed 40° when it was saturated with the chloride, the addition of alcohol precipitates only little of this salt, and, as it is very finely divided, washings with alcohol readily dissolve it. After standing for some hours the liquid is filtered, and the precipitate collected upon a filter is washed with alcohol, which does not dissolve the ammonium vanadate in an appreciable proportion. In agitating the aqueous solution with sal-ammoniac for the purpose of saturation it is well to avoid the use of a glass rod, as wherever it touches the glass crystals of vanadate are deposited, which adhere to the sides and are not easily removed with a pencil.

2. When the liquid in which we have to determine vanadic acid contains, in addition to the vanadate, other alkaline salts sparingly soluble in alcohol, they may be deposited along with the ammonium vanadate, and the process requires to be modified. We begin by saturating the liquid with ammonium chloride, of which a small excess is left undissolved; then 4 or 5 vols. of a saturated solution of the same salt are added, and the whole is let settle for some hours. The clear, supernatant liquid, containing the greater part of the foreign salts, is decanted through a filter, and it is replaced by fresh solutions of ammonium chloride, always taking care to leave a little of the undissolved salt. After standing five or six hours the decantation is resumed through the same filter, and, according to circumstances, the washing is repeated once or several times. Lastly, the filter is pierced, washed with boiling water to remove any traces of ammonium vanadate which may have been carried over during the decantations. The washing water is received in the glass containing the precipitate of ammonium vanadate which is partially re-dissolved. The new liquid thus obtained is free from foreign salts. It is saturated at 40° with ammonium chloride, and the operation is concluded as already described.

3. The filter containing the ammonium vanadate, well washed with alcohol, is dried in the stove. The deposit is let fall into a platinum capsule, the filter is placed above it, and it is heated gradually to redness. The filter burns, the vanadate is decomposed, the carbon of the filter burns in the air, and, lastly, the mass melts. It is kept for some time in fusion, so as to effect complete oxidation, and the capsule is weighed when cold.

When operating thus upon a few decigrms. of vanadic acid we might fear the formation of small quantities of the compound VO_4,VO_5, which is very difficult to oxidise under the circumstances. To avoid this slight cause of error the ignition is effected at dull redness, and, without troubling about burning the carbon of the filter, it, as well as the pulverulent matter arising from the decomposition of the ammonium vanadate, is moistened with a little pure nitric acid, and evaporated to dryness. The oxides of vanadium are converted into vanadic acid. The residue after evaporation is heated to redness, the relics of the filter quickly disappear, the vanadic acid melts, and is weighed when the crucible is cold.

4. If the vanadic acid is not in the state of an alkaline salt it must be converted into such, and the foreign oxides must be removed. The method of this operation varies according to the oxides present, and is often difficult. When the vanadium has been obtained as an alkaline vanadate the determination is effected as explained above. —*Comptes Rendus* (civ., p. 982).

THE LAW OF THE DISTRIBUTION OF RAYS AND BANDS COMMON TO SEVERAL BAND-SPECTRA.

ANALOGY WITH THE LAW OF SUCCESSION OF SOUNDS OF A SOLID BODY.

By M. DESLANDRES.

In a former communication the author has indicated a simple law which governs the distribution of the rays of one and the same band (*Comptes Rendus*, vol. ciii., p. 375), and which may thus be summarised:—In general the rays which compose one and the same band may be divided into series of identical rays entangled with each other, and such that in each series the intervals from one ray to the next following form approximately an arithmetical progression. Now this simple law of distribution is applicable also to the bands of one and the same band spectrum, and this new extension of the law forms the subject of the present paper.

The author represents a band by the original ray of one of its component arithmetical series, the original ray being the one placed at the extremity of the series on the side of the smallest intervals, and he has studied the distribution of these original rays. Now, when these rays are expressed in numbers of vibrations, he has again found, in a certain number of spectra, the simple law already indicated for the rays of one and the same band. The original rays may be divided into series, which have also this common property, that the intervals of one and the same series form approximately an arithmetical progression.

The first spectrum in which this law of distribution has been verified is the second group of the bands of nitrogen (from λ 500 to λ 280), which is remarkable for its great extent and its regularity; it presents at least fifty bands, and each band is formed by superposition of three equal and equidistant arithmetical serie . In what follows the

author considers only the original ray of the arithmetical series of the middle.

The description of the indices peculiar to this spectrum, which have led to its discovery, would present a certain interest, but it would take up too much space. The author's paper was accompanied by a diagram showing the five arithmetical series, which are equal in this spectrum, and which comprise all the original rays, whilst a table shows the agreement between the numbers as observed and as calculated.

In a former memoir he represented the rays of one and the same band by the formula $Am^2 + \alpha$, m being an entire number, which varies from 1 in 1, 2 in 2, 3 in 3, &c. In like manner the original rays of each series of bands will be given by the formula Bn^2+C, and the totality of the rays of a series by Am^2+Bn^2+C. The fourth series of the second group of nitrogen is thus represented by the formula $0{\cdot}145735 \times n^2 - 152{\cdot}533$.

The author has also verified the law in the following spectra: the third positive group of nitrogen (from λ 300 to λ 200), the original rays of which form four series; the group of the negative pole of nitrogen, with five series, the coefficient B of the two foregoing spectra being nearly equal to the coefficient B of the second group of nitrogen; the first positive group of nitrogen (from λ 700 to λ 500) with at least 3 series, which Dr. Hasselberg's accurate measurements render it possible to find; the spectrum ascribed to the hydrocarbons and that of carbon monoxide; lastly, the primary spectrum of iodine, which M. Thalen has decomposed into seven similar series. Now, if we express the bands in numbers of vibrations these series become progressions, and it is thus that the 36 bands of the first series are represented by the formula—

$$N = 198{\cdot}964 - 0{\cdot}0102985 \times n^2,$$

n varying from 16 to 51. The agreement with the numbers observed is sufficiently distinct, notwithstanding the smallness of the ratio in relation to the possible error in measurement.

This law, if we consider the number and the origin of the spectra cited, appears general, and it points to a common structure in spectra at first sight unlike, as the spectra of iodine and of the hydrocarbons. Further, if we prolong from the side of the smallest intervals the progressions of these spectra, which present only in general large intervals, we arrive at an entanglement of bands, which recalls the confused aspect of spectra more complex in appearance, such as those of bromine and of hyponitric acid. It is therefore permissible to hope that these spectra also may be referred to this general law.

But the author has carried this study still further for certain spectra, and in particular for the second group of nitrogen. He has prolonged from the side of the smallest intervals the five progressions which comprise all the bands, and he has examined if the originals of these new progressions were also connected by the same simple law. These originals are given by the constants of the formulæ $Am^2 + Bn^2 + C$, and are equal to $-134{\cdot}151$, $-152{\cdot}533$, $-171{\cdot}268$, $-190{\cdot}687$, $-210{\cdot}623$. Now the squares of these constants have intervals which form an arithmetical progression. We therefore substitute C by $\sqrt{Cp^2+y}$, p being a whole number.

On the other hand, the coefficient A has not the same value for all the bands of the spectrum. It appears to be a simple function of the parameters n^2 and p^2, which define the original ray of the band, but the study of this function is not completed, and in order to be executed with the accuracy desirable it requires a dispersion higher than that at the author's disposal. In any manner the spectrum considered may be represented by three almost identical formulæ, of the form $f(n^2, p^2) \times m^2 + Bn^2 - \sqrt{Cp^2+y}$.

These three formulæ correspond to the three identical and closely approximating arithmetical series (distant at most by $0^N{\cdot}100$) which compose each band of the group. The spectrum of the negative pole, the bands of which present a single series, will be represented by a single formula.

The above formula indicates a very distinct analogy between the distribution of the spectral rays and the succession of sounds of a solid body.—*Comptes Rendus*, civ., p. 972.

THE HARDNESS OF METALS.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S.,
Lecturer on Metallurgy, Mason College, Birmingham.

(Continued from p. 196.)

DURING last summer I had occasion to perform a number of tests of the hardness of cast-iron, at the Rosebank Foundry, Edinburgh. In this case a diamond was employed as before, but a balanced and graduated metal beam was used, the pressure being obtained by means of a sliding weight of about 80 grms. These results are given in Table C, and will be again mentioned. They agree fairly well with my other observations, though another diamond was employed with the modified apparatus.

My present arrangement is as follows (Fig. 3):—

It consists of a balanced and graduated beam of gun-metal, A, working on steel knife-edges, B, and counterpoised by means of the large sliding weight, F, the final adjustment being obtained by the screw, G. When balanced it is sensitive to 0·01 grm. at E, though such delicacy is probably not required. The knife-edges rest upon planes in the support, C, which is capable of rotating on a steel pivot connected with the rod, D. The diamond is mounted in a brass tube, having a milled head, and which is fixed by means of a screw at E. The specimen to be tested, which often takes the form shown, J, is supported by a wooden block, K. The weight, H, is arranged so that each division on the graduated scale shall correspond to a pressure of a grm. at the diamond point. Thus, at division 12, we have a pressure of 12 grms. on the diamond. Three extra weights, I, are used when necessary; they are each of the same weight as H. Hence, with one weight, scale division 10 corresponds to 10 grms. on the diamond, with two weights 10 corresponds to 20 grms., with three weights to 30 grms., and with four weights to 40 grms.; the other scale divisions being read in an exactly similar manner. It will be noticed that the specimen is stationary, while the diamond is moved, thus differing from the sclerometer as applied to minerals; the method of supporting the beam and of applying the weight is also different. In ordinary experiments, where considerable weights are applied, the diamond may be moved by the finger, and, as the apparatus is very steady in its action, with a little care this gives very concordant results. For more delicate observations, with smaller weights, the diamond may be drawn by means of a horizontal string running over a small pulley. The surface used is prepared roughly in the ordinary way by chipping, filing, &c., and then with a smooth file; it is finished with emery paper, using at least the finest variety, or flour, emery, and oil, according to the material. It should be finished all one way, so as not to leave small irregular scratches, and should be as smooth and bright as possible. As a rule an experienced workman should not take more than half-an-hour in preparing such a specimen, though occasionally a hard material will take longer. If the surface tested be rough the results are erroneous, being generally higher than with a good surface. It can, however, be told at once on inspection whether a surface is suitable for the purpose. If any doubt should exist, another smooth face must be prepared, and the experiment continued until uniform results are obtained.

Reference has already been made to the difficulty of reading the scratch, or, in other words, of detecting when

* Read before the Birmingham Philosophical Society, Dec. 9, 1886

abrasion begins. If the scratch is always read in the same way, uniform results can be obtained, but the actual value will depend upon the standard scratch used in the experiments. It is doubtless from this cause that my own values are higher than those of Franz, as will be shown later, though each set of experiments is in itself uniform.

In viewing a scratch on a smooth metallic surface there are two principal appearances observed. When viewed at certain angles, so that the metal is dark, the scratch is seen as a bright line; while if the metal is seen in another direction the scratch appears as a *dark* line on a bright surface. A smaller weight is required to produce a visible scratch if it be viewed as a bright line than if it appear a dark line on a bright surface. In my experiments the scratch was always viewed as a *dark* line, for the following reasons:—

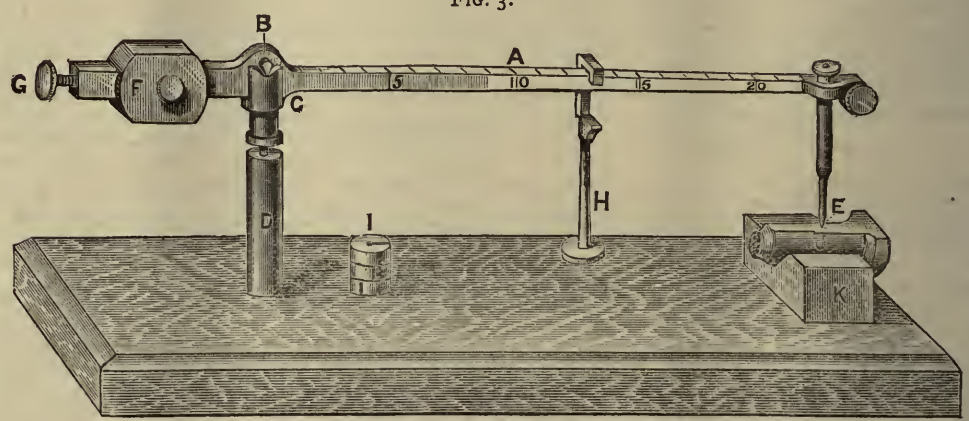
1. With a little experience, uniform results can be obtained in different observations on the same specimen.
2. The scratch produced being somewhat deeper when read by this method, a greater range is obtained with the instrument.
3. Because, as will be afterwards shown, this depth of scratch probably corresponds as nearly as possible with the beginning of abrasion.

the scratch. After considerable wear I have not detected any alteration in the weight required to mark a given specimen. The excellent wear of the diamond is probably due to the fact that the heaviest weight used is only 92 grms., or about three ounces. But though the diamond thus appears to have little effect on the results, the influence of a rough surface, a bad light, or a different method of observation, is very considerable. The character of the surface has already been sufficiently explained. A bright diffused light is best, and the specimen should be placed near to a window, and in such a position that the reflection from bright objects in the room, white walls, &c., should interfere as little as possible. From this cause it will be found extremely difficult to obtain accurate results in some positions.

As it has been suggested that this apparatus might be very useful for practical purposes, and several practical men have already expressed their intention of adopting it, I shall venture to give a detailed description of the method of observation.*

The surface of the metal having been properly prepared, and a suitable position as regards light having been chosen, the specimen is fixed horizontally under the point of the diamond. By means of the movable weight (F) and adjusting screw (G) the diamond is now carefully balanced just above the smooth surface. The four weights are then

Fig. 3.

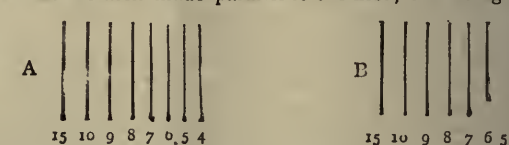


A. Beam.
B. Knife-edge.
C. Rotating Support.
D. Steel Rod and Pivot.
E. Diamond.
F. Sliding Weight.
G. Adjusting Screw.
H. Sliding Weight.
I. Extra Weights.
J. Test Piece.
K. Wooden Support.

Attempts were made to read the scratch by means of a lens or a microscope, but without much success.

When magnified, the scratches produced by gradually increasing weights appear to change by almost imperceptible degrees, and no definite point can be fixed upon as that at which the action commences. But on comparing a deep scratch with a very faint one a marked difference can be seen. In the case of a light scratch the surface appears to be merely smoothed over by the passage of the diamond, while with a deeper scratch the material is torn up, and a distinct ridge produced. In my method of observing the scratch I have endeavoured to take that point at which this tearing up of the surface, or abrasion, begins. Even when viewed under the microscope this point is not definite, and hence the method I employed must be regarded merely as an arbitrary one, intended to approach as nearly as possible to the theoretical conception. In these experiments three different diamonds have been employed, and very concordant results obtained in each case, care being taken always to work as nearly as possible in the same manner. The diamond is octahedral, and set so that the point of the crystal is used to produce

placed on the beam in such a position that a definite scratch is produced on drawing the diamond over the metal; the point being drawn once forward and once backwards over the same line. A definite scratch, necessary to guide the eye, having been thus produced, the weights are placed on a lower scale division and another scratch made parallel to the first; this being re-



peated as often as necessary, the weight meanwhile being gradually reduced. In the case of a mild steel requiring a weight of 21 grms. the weights might at first be placed, say, at 15, then at 10, afterwards at 9, 8, 7, 6, 5, and 4 in

* Arrangements are being made with a Birmingham firm for the supply of this form of apparatus to manufacturers and others to whom it might be useful. I shall be glad to examine each sclerometer before it is sent out for those who may desire it.

succession, a number of parallel lines being made which viewed as bright lines on a dark surface appear as in A, gradually becoming less distinct, but all clearly visible. But on viewing the same lines at the proper angle, as dark lines on a bright surface, they would appear as in B, No. 6 being very faint, while No. 5 is invisible, or only seen with the greatest difficulty, and No. 4 is visible.

The result is, therefore, as follows:—

Scale Division.	Weight in Grms.	Result.
15	15×4=60	Plainly visible.
10	40	,,
9	36	Visible.
8	32	,,
7	28	,,
6	24	Faintly visible.
5	20	Value taken.
4	16	Invisible.

By means of the four weights, therefore, it has been shown that the hardness is somewhere between 16 and 24. A similar series of operations is now gone through with three weights on the beam, when probably a value of 7, equal to a weight of 21 grms., would be obtained.

On using two weights, probably a value of 11 would be obtained, corresponding to a weight of 22 grms. It will be pretty certain from these experiments, if carefully performed, that the true value must lie about 20—22 grms. The number is now determined by means of the single weight. For this purpose a distinct line is made, so as to guide the eye, and then a series of parallel lines are made, beginning with division 24 perhaps, and ending with about 18. The specimen is then carefully examined and the proper line chosen; the experiment being repeated until a satisfactory result is obtained. With practice, uniform values are obtained for the same specimen, and the error should not exceed ± 5 per cent. In cases of doubt, it is very easy to refer to a standard specimen, and the whole operation generally occupies about a quarter of an hour. A novice can at once distinguish between specimens that differ much in hardness, as for instance in the examples given in Tables A and B; but experience is required before different specimens of pretty uniform hardness, such as mild steel, can be distinguished.

(To be continued).

THE ANALYSIS OF SUGAR-CANE AND BEET JUICES, WITH A TABLE FOR THE CALCULATION OF ANALYSES.

By C. A. CRAMPTON.

In the routine work of cane- and beet-sugar houses, the greater part consists in the analysis of large numbers of samples of juice. A method of manipulation for these analyses is therefore desirable which will unite a reasonable degree of accuracy with considerable speed. It is from the desire of contributing to this end that this article was written, and not with the intention of presenting anything new in the way of processes. The method and routine of analysis given below has been pursued by myself and others for several years in the work of the U. S. Department of Agriculture, in its experiments on sorghum and sugar-cane, and found very expedient in the brief "sugar season," when the saving of time is so important an object. For very accurate work, of course, it is necessary to weigh out the sample of juice taken for analysis, but for all ordinary purposes the sample may be measured by volume, increasing greatly thereby the rapidity of the operations. By taking the sp. gr. with accurate spindles, having their graduations well spaced, and correcting the valence taken, a very close approximation to the actual weight is obtained; the correction may be applied in two ways:—

1. By dividing the normal weight for the polariscope, or a multiple of it, by the sp. gr. of the juice, to find the number of c.c. of the liquid exactly corresponding to this weight, and then measuring out this quantity from a burette into a 100 c.c. flask, adding subacetate of lead solution, making up the volume to 100 c.c., filtering, and polarising. The reading of the polariscope gives directly the per cent of sugar in the juice, only multiplied by the number of times the normal weight was taken.

2. By measuring out a certain volume of the juice, adding lead solution, making up to another definite volume, and polarising and applying the correction for sp. gr. to the reading obtained.

I prefer the latter method as more expeditious and convenient, for in the other the sp. gr. must be determined and a calculation made, before the sample for polarisation can be taken; while in the second method the sp. gr. may be taken at any time through the day, and the calculation of the results postponed indefinitely.

The custom among sugar chemists in the best houses in France and Germany is to measure 100 c.c. of juice in a flask graduated to 100 and 110 c.c., add 10 c.c. of a dilute solution of subacetate of lead, filter, and polarise; the increase in volume being corrected, either by reducing in a 220 m.m. tube, or by adding one-tenth to the reading. I have found it more advantageous however, to take 50 c.c. of the juice, add lead, and make the volume up to 100; this gives a much more satisfactory liquid for polarisation, especially with impure juices, and the filtration is greatly facilitated. The only object attained by using 100 c.c. is the increase of the reading, and consequent lessening of errors of observation; this is of but little importance, however, as 50 c c. is two or three times the normal quantity for most instruments. Even this objection may be done away with by using a double length (400 m.m.) tube, providing the instrument used will admit of the long tube, and this is entirely practicable as far as the lucidity of the solution is concerned, for I have never failed to get clean bright solutions by proceeding in the manner I have indicated, except in cases where juices had been allowed to stand, and mucous fermentation had set in.

The detailed procedure is as follows:—

50 c.c. of the juice is measured out by means of an accurately calibrated pipette, and run into a 100 c.c. flask; to it is added from 1 to 4 c.c. of a strong solution of subacetate of lead,* the whole made up to the mark with water, filtered, and polarised.

The same solution is then used for the determination of the reducing sugars by Fehling's solution—the excess of lead being precipitated by sulphate of soda. As the reduction of copper suboxide by sugars has been shown to be affected by the amount of dilution in which the action takes place, it is desirable to have, as nearly as possible, a constant amount of dilution, and the most favourable dilution is such, that from 10 to 20 c.c. of the solution will be required to reduce the copper from 10 c.c. of Fehling's solution; so, for juice presumed to contain from 1 to 2 per cent of reducing sugars, 50 c.c. of the solution which has been polarised, made up to 100 c.c., will furnish the proper dilution; for those containing from 2 to 3 per cent, 50 c.c. to 150 c.c., and so on. In the case of juices containing less than 1 per cent of reducing sugars, the excess of lead may be removed by adding the sodic sulphate† before the lead precipitate is filtered off, when the same solution can be used for polarisation and for the reducing sugar determination. The copper solution used is Violetti's modification, and the operation is performed in large test-tubes, 9 to 10 inches long, and of about 1 to 1½ in. calibre, and the end reaction is obtained with ferro-

* Prepared by rubbing up in a mortar 1 kilo. of subacetate of lead with ½ kilo. of litharge, and boiling with ½ litre of water.

† For very exact work it is better to take a separate sample of the juice for the copper test, and to dispense with lead altogether if the purity of the juice admits, for the presence of lead produces an error and even when precipitated by sulphate of soda there is said to be an error, from the slight solubility of the sulphate of lead.

cyanide of potash and acetic acid, the small portion of clear liquid required being filtered out by means of Wiley's tubes, already described.* These tubes are simply glass ubes about 9 to 10 in. long and ¼ in. in calibre; at one extremity a slight rim is made by turning back the edge while hot, and over this is stretched and tied a piece of fine linen cloth. To use the tube, it is inserted into a beaker of water, containing in suspension a quantity of very finely ground asbestos pulp; by suction at the other end of the tube, the linen cap is covered with a film of asbestos, and it is then immediately inserted into the test-tube containing the hot precipitated Fehling's solution; suction is again made on the tube, and the portion of clear liquid obtained is run into the porcelain dish containing the test solution by simply inverting the tube. These tubes may be cleaned and used over and over again by washing off the asbestos film, dissolving out any suboxide of copper which may remain in the cloth by soaking in nitric acid and rinsing in water until they no longer taste acid. One covering of linen suffices for many tests, and when worn out it is easily replaced.

Working in this way a large number of samples can be analysed in a day—25 to 30 being generally a fair day's work for operators on the stations of the Department of Agriculture, both sucrose and glucose being determined, and also the total solids (from the sp. gr.), and this number is much exceeded, in case of stress of work, by allowing the polarisations to stand over until night, using all the daylight for glucose determinations. By having a boy to measure out the samples and prepare them for analysis the amount of work done can be nearly doubled.

It remains to calculate the results obtained, and to facilitate this calculation I have compiled the following table. In it will be found the sp. gr. and degree Brix,† and opposite to him factors for the calculation of sucrose and glucose in juices of the corresponding sp. gr., according to the method of procedure given above. Two factors for sucrose are given, one for instruments using as a normal quantity 26·048 grms., such as the Soleil-Schiebler, and one for those using 16·3 grms., such as the Laurent.‡ These factors are the quotients arising from division of the normal quantities by (50 × sp. gr.), and to use them it is necessary simply to multiply them by the reading of the polariscope, the result giving directly the per cent of sucrose in the juice. The glucose factor is simply the reciprocal of the sp. gr. with the decimal point changed. To use it, it is divided by the number of c.c. of the normal solution (50 c.c. of juice to 100) required to precipitate 10 c.c. of Fehling's solution, which gives the result directly in per cents. If the solution has been diluted twice (50 c.c. to 200) divide the factor by half the number of c.c. required, if one and a half times (50 c.c. to 150) by one and a half times the number of c.c. required, and so on.

TABLE FOR CALCULATION OF ANALYSES OF CANE AND BEET JUICES.

Specific gravity.	Degree Brix.	Sucrose factor for instruments requiring 26·048 grms.	Sucrose factor for instruments requiring 16·3 grms.	Glucose factor.
1·0197	5·0	0·5109	0·3197	9·807
1·0201	5·1	0·5107	0·3196	9·803
1·0205	5·2	0·5105	0·3195	9·799
1·0209	5·3	0·5103	0·3193	9·795
1·0213	5·4	0·5101	0·3192	9·791
1·0217	5·5	0·5099	0·3191	9·788
1·0221	5·6	0·5097	0·3190	9·784
1·0225	5·7	0·5095	0·3189	9·780
1·0229	5·8	0·5093	0·3187	9·776
1·0233	5·9	0·5091	0·3186	9·772
1·0237	6·0	0·5089	0·3185	9·768
1·0211	6·1	0·5087	0·3184	9·765
1·0245	6·2	0·5085	0·3183	9·761
1·0249	6·3	0·5083	0·3182	9·757
1·0253	6·4	0·5081	0·3181	9·753
1·0257	6·5	0·5079	0·3180	9·749
1·0261	6·6	0·5077	0·3178	9·746
1·0265	6·7	0·5075	0·3177	9·742
1·0269	6·8	0·5073	0·3175	9·738
1·0273	6·9	0·5071	0·3174	9·734
1·0277	7·0	0·5069	0·3173	9·730
1·0281	7·1	0·5067	0·3171	9·727
1·0286	7·2	0·5065	0·3170	9·723
1·0290	7·3	0·5063	0·3169	9·719
1·0294	7·4	0·5061	0·3167	9·715
1·0298	7·5	0·5059	0·3166	9·711
1·0302	7·6	0·5057	0·3164	9·707
1·0306	7·7	0·5055	0·3163	9·703
1·0310	7·8	0·5053	0·3162	9·699
1·0314	7·9	0·5051	0·3160	9·696
1·0318	8·0	0·5049	0·3159	9·692
1·0322	8·1	0·5047	0·3158	9·688
1·0327	8·2	0·5045	0·3157	9·684
1·0231	8·3	0·5043	0·3156	9·680
1·0335	8·4	0·5041	0·3154	9·676
1·0039	8·5	0·5039	0·3153	9·672
1·0343	8·6	0·5037	0·3152	9·668
1·0347	8·7	0·5035	0·3151	9·665
1·0351	8·8	0·5033	0·3150	9·661
1·0355	8·9	0·5031	0·3148	9·657
1·0359	9·0	0·5029	0·3147	9·653
1·0364	9·1	0·5027	0·3146	9·649
1·0368	9·2	0·5025	0·3144	9·645
1·0372	9·3	0·5023	0·3143	9·641
1·0376	9·4	0·5021	0·3142	9·638
1·0380	9·5	0·5019	0·3141	9·634
1·0384	9·6	0·5017	0·3140	9·630
1·0388	9·7	0·5015	0·3138	9·626
1·0393	9·8	0·5013	0·3137	9·622
1·0397	9·9	0·5011	0·3136	9·618
1·0401	10·0	0·5009	0·3134	9·614
1·0405	10·1	0·5007	0·3133	9·611
1·0409	10·2	0·5005	0·3132	9·607
1·0413	10·3	0·5003	0·3131	9·603
1·0418	10·4	0·5001	0·3129	9·599
1·0422	10·5	0·4999	0·3128	9·595
1·0426	10·6	0·4997	0·3127	9·591
1·0430	10·7	0·4995	0·3126	9·588
1·0434	10·8	0·4993	0·3125	9·584
1·0439	10·9	0·4991	0·3123	9·580
1·0443	11·0	0·4989	0·3122	9·576
1·0447	11·1	0·4987	0·3121	9·572
1·0451	11·2	0·4985	0·3119	9·568
1·0455	11·3	0·4983	0·3118	9·565
1·0459	11·4	0·4981	0·3117	9·561
1·0464	11·5	0·4979	0·3115	9·557
1·0468	11·6	0·4977	0·3114	9·553
1·0472	11·7	0·4975	0·3113	9·549
1·0476	11·8	0·4973	0·3112	9·545
1·0481	11·9	0·4971	0·3110	9·541
1·0485	12·0	0·4969	0·3109	9·537
1·0489	12·1	0·4967	0·3108	9·534
1·0493	12·2	0·4965	0·3107	9·530
1·0497	12·3	0·4963	0·3106	9·527
1·0502	12·4	0·4961	0·3104	9·523
1·0506	12·5	0·4959	0·3103	9·519
1·0510	12·6	0·4957	0·3102	9·515
1·0514	12·7	0·4955	0·3101	9·511
1·0519	12·8	0·4953	0·3099	9·507
1·0523	12·9	0·4951	0·3098	9·503
1·0527	13·0	0·4949	4·3097	9·499
1·0531	13·1	0·4947	0·3096	9·496
1·0536	13·2	0·4945	0·3094	9·491
1·0540	13·3	0·4943	0·3093	9·488

* *Bull. de l'Ass. des Chim. de Sucr. et de Dist.*, ii., 108.

† Taken from the tables of Mategczek, Schiebler, and Stamme, as given by Dr. Tucker in his "Manual of Sugar Analysis."

‡ For the accuracy of this quantity for Lanrent's polariscope see *Bull. de l'Assoc. des Chim. de Sucr. et de Dist.*, 1885, Nos. 8 and 9, p. 255, and *Ann. Chem. Jour*, viii., p. 51.

Specific gravity.	Degree Brix.	Sucrose factor for instruments requiring 26·048 grms.	Sucrose factor for instruments requiring 16·3 grms.	Glucose factor.
1·0544	13·4	0·4941	0·3092	9·484
1·0548	13·5	0·4939	0·3091	9·480
1·0553	13·6	0·4937	0·3090	9·476
1·0557	13·7	0·4935	0·3088	9·472
1·0561	13·8	0·4933	0·3087	9·469
1·0566	13·9	0·4931	0·3085	9·464
1·0570	14·0	0·4929	0·3084	9·461
1·0574	14·1	0·4927	0·3083	9·457
1·0578	14·2	0·4925	0·3082	9·453
1·0583	14·3	0·4923	0·3080	9·449
1·0587	14·4	0·4921	0·3079	9·446
1·0591	14·5	0·4919	0·3078	9·442
1·0596	14·6	0·4917	0·3077	9·438
1·0600	14·7	0·4915	0·3076	9·434
1·0604	14·8	0·4913	0·3074	9·430
1·0609	14·9	0·4911	0·3073	9·426
1·0613	15·0	0·4909	0·3072	9·422
1·0617	15·1	0·4907	0·3071	9·419
1·0621	15·2	0·4905	0·3069	9·415
1·0626	15·3	0·4903	0·3068	9·411
1·0630	15·4	0·4901	0·3067	9·407
1·0634	15·5	0·4899	0·3066	9·404
1·0639	15·6	0·4897	0·3064	9·399
1·0643	15·7	0·4895	0·3063	9·396
1·0647	15·8	0·4893	0·3062	9·392
1·0652	15·9	0·4891	0·3061	9·388
1·0656	16·0	0·4889	0·3059	9·385
1·0660	16·1	0·4887	0·3058	9·381
1·0665	16·2	0·4885	0·3057	9·377
1·0669	16·3	0·4883	0·3056	9·373
1·0674	16·4	0·4881	0·3054	9·369
1·0678	16·5	0·4879	0·3053	9·365
1·0682	16·6	0·4877	0·3052	9·362
1·0687	16·7	0·4875	0·3051	9·358
1·0691	16·8	0·4873	0·3049	9·354
1·0695	16·9	0·4871	0·3048	9·350
1·0700	17·0	0·4869	0·3047	9·346
1·0704	17·1	0·4867	0·3046	9·342
1·0709	17·2	0·4865	0·3044	9·338
1·0713	17·3	0·4863	0·3043	9·334
1·0717	17·4	0·4861	0·3042	9·331
1·0722	17·5	0·4859	0·3041	9·327
1·0726	17·6	0·4857	0·3039	9·323
1·0730	17·7	0·4855	0·3038	9·320
1·0735	17·8	0·4853	0·3037	9·315
1·0739	17·9	0·4851	0·3036	9·312
1·0744	18·0	0·4849	0·3034	9·308
1·0748	18·1	0·4847	0·3033	9·304
1·0753	18·2	0·4845	0·3032	9·390
1·0757	18·3	0·4843	0·3031	9·296
1·0761	18·4	0·4841	0·3029	9·293
1·0766	18·5	0·4839	0·3028	9·289
1·0770	18·6	0·4837	0·3027	9·285
1·0775	18·7	0·4835	0·3026	9·281
1·0779	18·8	0·4833	0·3024	9·277
1·0783	18·9	0·4831	0·3023	9·274
1·0788	19·0	0·4829	0·3022	9·270
1·0792	19·1	0·4827	0·3021	9·266
1·0797	19·2	0·4825	0·3019	9·262
1·0801	19·3	0·4823	0·3018	9·258
1·0806	19·4	0·4821	0·3017	9·254
1·0810	19·5	0·4819	0·3016	9·251
1·0815	19·6	0·4817	0·3014	9·246
1·0819	19·7	0·4815	0·3013	9·243
1·0824	19·8	0·4813	0·3012	9·239
1·0828	19·9	0·4811	0·3011	9·235
1·0832	20·0	0·4809	0·3009	9·232
1·0837	20·1	0·4807	0·3008	9·228
1·0841	20·2	0·4805	0·3007	9·224
1·0846	20·3	0·4803	0·3006	9·220
1·0850	20·4	0·4801	0·3005	9·216
1·0855	20·5	0·4798	0·3003	9·212
1·0859	20·6	0·4797	0·3002	9·209
1·0864	20·7	0·4795	0·3001	9·205
1·0868	20·8	0·4794	0·3000	9·201
1·0873	20·9	0·4791	0·2998	9·197
1·0877	21·0	0·4790	0·2997	9·194
1·0882	21·1	0·4787	0·2996	9·190
1·0886	21·2	0·4786	0·2995	9·186
1·0891	21·3	0·4783	0·2993	9·182
1·0895	21·4	0·4782	0·2992	9·179
1·0900	21·5	0·4779	0·2991	9·174
1·0904	21·6	0·4778	0·2990	9·171
1·0909	21·7	0·4775	0·2988	9·167
1·0914	21·8	0·4773	0·2987	9·163
1·0918	21·9	0·4772	0·2986	9·159
1·0923	22·0	0·4769	0·2984	9·155
1·0927	22·1	0·4768	0·2983	9·151
1·0932	22·2	0·4765	0·2982	9·148
1·0936	22·3	0·4764	0·2981	9·144
1·0941	22·4	0·4762	0·2980	9·140
1·0945	22·5	0·4760	0·2979	9·137
1·0950	22·6	0·4758	0·2977	9·132
1·0954	22·7	0·4756	0·2976	9·129
1·0959	22·8	0·4754	0·2974	9·125
1·0964	22·9	0·4752	0·2973	9·121
1·0968	23·0	0·4750	0·2972	9·117
1·0973	23·1	0·4748	0·2971	9·113
1·0977	23·2	0·4746	0·2970	9·110
1·0982	23·3	0·4744	0·2968	9·106
1·0986	23·4	0·4742	0·2967	9·102
1·0991	23·5	0·4740	0·2966	9·098
1·0966	23·6	0·4738	0·2965	9·094
1·1100	23·7	0·4736	0·2963	9·091

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, February 22nd, 1887.

Professor OSBORNE REYNOLDS, LL.D., F.R.S., Vice-President, in the Chair.

"*On the Delicacy of Spectroscopic Reaction in Gases.*' By T. W. BEST. Communicated by Dr. ARTHUR SCHUSTER, F.R.S.

Seeing that very minute quantities of a great many bodies can be detected with ease in the spectroscope, at the request of Sir Henry Roscoe the following experiments were undertaken with the view of testing the efficiency of the spectroscope as a means for ascertaining the purity of gases.

The three gases, hydrogen, nitrogen, and oxygen, only were experimented upon: thus the smallest amount of hydrogen, whose spectrum could be observed in that of nitrogen, and *vice versa*, was first determined; and then the smallest amount of nitrogen in oxygen, and oxygen in nitrogen respectively, at the atmospheric pressure.

Apparatus used.

1. Spectroscope. 2. Induction coil. 3. Eudiometer.

1. The collimator, prism stage, and telescope of the spectroscope were mounted on separate stands; only one prism was used whose angle is 59° 33′, and the magnifying power of the telescope is 26·9.

Only about a quarter of the length of the spectrum could be seen in the spectroscope at once, and there being no scale the position of the lines sought after had to be measured from known gas lines, by a micrometer screw and pointer attached to the eyepiece.

2. An induction coil was used with a small Leyden jar

in the circuit to obtain the spectrum. Under ordinary conditions the length of spark in air, with jar in circuit, was 1·5 c.m., while without the jar a spark = 5·2 c.m. in length could be obtained.

3. Two eudiometers were used, 70 c.m. long, 1·9 c.m. wide, graduated up to 160 c.c., and having aluminium electrodes 0·25 c.m. apart sealed into the side at a distance of 30 c.m. from the bottom; the tap at the top serving to let in, from a burette, the required amount of gas.

To get rid of all the air the eudiometer was filled with mercury, by exhausting the air above it with a water-pump.

In most cases when the spectrum was observed the gases were under a pressure reduced by 1 inch of mercury, —*i.e.*, the mercury stood about 1 inch higher in the tube than in the trough.

Unless specified to the contrary the gases were thoroughly dried by standing for a few hours over phosphoric anhydride.

The phosphoric anhydride was rammed tightly into a small tube which can be slipped into the eudiometer through the mercury, a hole being bored through the mass of P_2O_5 to allow the mercury to run off the top of it, and thus expose its surface to the gas.

Each gas had its own tube of P_2O_5, so that each tube of P_2O_5 did not become contaminated with more than one gas.

Experiments were tried with—

(*a*) Nitrogen in hydrogen.
(*b*) Hydrogen in nitrogen.
(*c*) Nitrogen in oxygen.
(*d*) Oxygen in nitrogen.

(*a*) *Nitrogen in Hydrogen.*

The hydrogen was generated by the action of sulphuric acid on zinc, washed and dried by passing through water and strong sulphuric acid, and after coming off for some time was collected over mercury.

The eudiometer is then placed in front of the spectroscope slit (at a distance of ½ metre), the spark focussed on to the slit by means of a small lens, and the spectrum examined.

If nitrogen or oxygen are not visible, and only the three hydrogen bands are present, then air (or, in some experiments, pure nitrogen) is added to the hydrogen in small quantities (about 1 c.c.) at a time, and the spectrum observed between each addition.

Thus, in one case, to 143 c.c. hydrogen was added to 1 c.c. air and the nitrogen lines were not visible, so another 1 c.c. air was added; but now the nitrogen green line wave-length 5004 was seen very faintly, and on the addition of another 1 c.c. air it could easily be seen. Therefore the amount of nitrogen that must be present in hydrogen in order to be detected in the spectroscope is 1·1 per cent.

Again, to 130 c.c. hydrogen 1 c.c. pure nitrogen (made by passing air over thin sticks of phosphorus in Hempel's gas analysis bulbs) was added, from a Hempel's burette, but the nitrogen line was not seen; so 0·5 c.c. more nitrogen was added, and now the nitrogen green line was seen, but it was rather faint. This gives 1·1 per cent.

To another 130 c.c. hydrogen, not dried at all, 1 c.c. nitrogen was added, but no nitrogen lines appeared; 0·6 c.c. more nitrogen was added, and the nitrogen line was then seen. This gives 1·2 per cent.

To 118 c.c. hydrogen, dried by having concentrated sulphuric acid in the eudiometer on the top of the mercury, 1 c.c. nitrogen was added, and the nitrogen line was not then visible: on addition of 0·2 c.c. more nitrogen the nitrogen line was not visible, but on addition of 0·2 c.c. more it came again into view. This gives 1·2 per cent. Mean of the four experiments is 1·15.

Therefore the amount of hydrogen that must be present in hydrogen to be detected in the spectroscope is 1·1 per cent.

Again, 4·5 c.c. nitrogen were added to 143 c.c. hydrogen, and the nitrogen line wave-length 5004 was easily seen; on adding 1 c.c. more nitrogen the yellow nitrogen lines wave-lengths 5681 and 5666 came out, and another green line wave-length 5164 makes its appearance on the addition of 2·5 c.c. more.

The result is not affected in the least, whether air pure nitrogen is added to the hydrogen.

(*b*) *Hydrogen in Nitrogen.*

To 112 c.c. pure nitrogen (made by the method already given) 6·7 c.c. hydrogen were added, and the green and red hydrogen bands were distinctly visible.

To 144 c.c. nitrogen 1·6 c.c. hydrogen were added, and the green band became visible, not as a band, but as a very broad, thick line, quite sharp at the edges, and on the addition of more hydrogen it widened out into a band. The red hydrogen band was also visible at this time as a broad line.

To 140 c.c. nitrogen 0·35 hydrogen was added; the red hydrogen band was easily seen, but the green band only flashed in occasionally as a broad line. On addition of 0·3 c.c. more hydrogen it was still a broad line, and broadened out into a band on adding more hydrogen.

Therefore the amount of hydrogen that must be present in nitrogen in order that the green band in its spectrum may be observed in the spectroscope is 0·25 per cent.

(*c*) *Nitrogen in Oxygen.*

The oxygen was made by decomposing potassium chlorate, passing the gas through NaOH and H_2SO_4, and collecting over mercury, as usual.

To 153 c.c. oxygen 2·9 c.c. nitrogen were added, and the nitrogen green line wave-length 5004 was visible.

To 132 c.c. oxygen 2 c.c. nitrogen were added, and the nitrogen line was again seen. The gas was not dried in the above two experiments at all.

To 130 c.c. oxygen 1 c.c. nitrogen was added, and the nitrogen line was seen, but it was very faint. This gives 0·78 per cent.

To 128 c.c. oxygen 0·6 c.c. nitrogen was added, and the nitrogen line was not seen; on adding 0·8 c.c. more nitrogen the green nitrogen line wave-length 5004 was visible, and on addition of 0·3 c.c. more nitrogen it could easily be seen.

Therefore the smallest amount of nitrogen that must be present in oxygen in order to be detected in the spectroscope is 0·8 per cent.

(*d*) *Oxygen in Nitrogen.*

To 127 c.c. nitrogen 30 c.c. air had to be added before the oxygen blue line wave-length 4648 became visible. This gives 4·7 per cent.

To 108 c.c. nitrogen 22·6 c.c. air were added before the oxygen line became visible. This gives 4·5 per cent.

To 104 c.c. nitrogen 5 c.c. oxygen were added, and the oxygen line was seen very easily.

To 138 c.c. nitrogen 4 c.c. oxygen were added, and the oxygen line was not visible, but on adding 3 c.c. more oxygen it could be seen easily. This gives 4·4 per cent. In the last two experiments the gas was not dried at all.

Therefore the amount of oxygen that must be present in nitrogen in order to be detected in the spectroscope is 4·5 per cent.

The addition of air to the oxygen gives the same result as adding pure nitrogen to the oxygen, so that it is immaterial which is used; neither does the dryness of the gas seem to affect the results.

The following experiments were made at diminished pressures, to see how the above results are affected at different pressures:—

Thus, to 95 c.c. hydrogen, at 11 inches mercury pressure, 1·5 c.c. air was added, and the nitrogen line was just visible. Now 95 c.c. hydrogen at 11 inches pressure = 35 c.c. at 30 inches pressure, and this gives 3·5 per cent nitrogen.

Again, to 90 c.c. at 10 inches pressure were added—

0·5 c.c. air, and no nitrogen lines were visible.
0·3 c.c. air more, „ „ „
0·4 c.c. air more, „ „ „
0·2 c.c. air more, and nitrogen line became visible.

Therefore 1·4 c.c. air in 30 c.c. hydrogen = 3·7 per cent nitrogen.

Thus a diminution of pressure from 29½ inches to 10½ inches mercury alters the amount of nitrogen that must be present in hydrogen in order to be detected in the spectroscope from 1·1 per cent to 3·6 per cent.

96 c.c. hydrogen at 2 inches pressure *showed the three hydrogen bands as wide lines, sharp at the edges, the red being the broadest.* On the addition of 0·25 c.c. air the nitrogen line wave-length 5004 was seen at the edges of the field only, and not extending across.

On adding further small quantities of air (up to 3·8 c.c.) more nitrogen lines came into view, till at last they were all in view, but they were only visible at the edges of the field, and would not extend across the field. The hydrogen lines became broader on each addition of nitrogen, and ultimately they became bands. At the end of the experiment the pressure had increased to 2¾ inches mercury.

To 101 c.c. hydrogen at 3½ inches pressure—

0·04 c.c. air was added, but no nitrogen lines appeared.
0·16 c.c. air „ „ „ „
0·26 c.c. air „ „ „ „
0·1 c.c. air the nitrogen green line appeared at the edges only.
0·2 c.c. air the nitrogen green line became much clearer.

Thus 0·36 c.c. air = 0·29 nitrogen in 11·8 c.c. hydrogen = 2·5 per cent.

Therefore at 3½ inches of mercury pressure the smallest amount of nitrogen that must be present in hydrogen in order that it may be detected in the spectroscope is 2·5 per cent.

Complete Results.

		Per cent.	
a. Nitrogen in hydrogen at atmospheric pressure,		1·1	N.
Nitrogen in hydrogen at 10½ inches	„	3·6	N.
Nitrogen in hydrogen at 3½ „	„	2·5	N.
b. Hydrogen in nitrogen at atmospheric	„	0·25	H.
c. Nitrogen in oxygen	„ „	0·8	N.
d. Oxygen in nitrogen	„ „	4·5	O.

NOTICES OF BOOKS.

Joint Scientific Papers. By James Prescott Joule, D.C.L., F.R.S., &c. Published by the Physical Society of London. London: Taylor and Francis. 1887. Vol. II.

The first paper in this volume is the joint work of Dr. Joule and the Rev. Wm. Scoresby, D.D., and is entitled "Experiments and Observations on the Mechanical Powers of Electro-Magnetism, Steam, and Horses."

The experiments consisted chiefly in causing armatures of special construction to revolve in front of steel magnets, by means of a current from a Daniell's battery: the current passing and the power developed were measured, and the maximum available duty of such an apparatus was found to be equal to 80 lbs. lifted 1 foot per grain of zinc consumed, or about half the theoretical maximum. These results are then compared with those obtained with two other sources of power, viz., steam and horses, from which it is found that a boiler and steam-engine in its most improved form is not able to convert more than one-tenth of the *vis viva* due to the combustion of coal into useful power. Similar observations of the power of a horse and the food it consumes show that only one-quarter of the *vis viva* generated by the food is converted into a useful mechanical effect, the remaining three-quarters being required to keep up the animal heat, &c.

The second paper is a very elaborate and laborious one, on "Atomic Volume and Specific Gravity," by J. P. Joule and Dr. Lyon Playfair, and extends over more than 200 pages. The importance of discovering the law which governs the volumes of solid and liquid substances has long been recognised, and has received considerable attention for some time past. Dr. Thomson was the first chemist who called attention to this subject, in the year 1831, and since then others—including Kopp, Schröder, and Persoz—have by their researches thrown considerable light on the matter.

Hitherto the enquiry has been principally confined to solid bodies; but the fact that they do not present matter in a uniform condition, free from cohesion, constitutes an objection to their use. The authors therefore thought it desirable to separate the particles so as to destroy their cohesion, without at the same time altering their chemical properties; they accordingly resolved to have recourse to solution in water as a means for effecting their purpose, and to experiment principally on soluble bodies of well-known constitution. It was of course necessary, at the same time, to determine the relation of the solid volume to the volume of the salt in solution, and also the specific gravities of the salts used, about which very little was known. An immense number of salts were tried and determined; they were divided into eight sections, such as nitrates, carbonates, oxalates, chromates, &c. The results of all these experiments are given in detail, and the various groups and sub-sections are given in tabulated form.

The laws which it is considered regulate the volumes of salts are summed up in the form of two propositions, as follows:—

Prop. I.—*Compounds dissolved in water increase its volume for every equivalent either by 9 or by multiples of 9.*

Prop. II.—*The volume occupied by a salt in the solid state has a certain relation to the volume of the same salt when in solution, and has also a fixed relation to the volume occupied by any other salt.*

Series II. deals with "The relation in volumes between simple bodies, their oxides, and sulphurets, and on the differences exhibited by polymorphous and allotropic substances." In this memoir the authors endeavour to confirm the multiple relation which was pointed out in the case of solid salts, and they commence with the volumes of the metallic elements. As in the previous experiments with salts in solution, the substances under experiment are divided into sections. Section I, deals with the specific gravities and volumes of the metallic elements; and the conclusions drawn from these experiments are that the metals, when obtained in a finely divided state, so as to be deprived of cohesion, and also when rendered fluid by heat, have volumes which are multiples of the unit 1·225, but the volumes of metals in the solid crystalline condition are, in general, multiples of a number about 1-20th less than 1·225. Then follow the sections on the oxides of the metals, the sulphurets, the non-metallic elements and their oxides, &c.

The results are announced generally under the following proposition:—

"The volumes of solid bodies bear a simple relation to each other, being multiples of a sub-multiple of the volume of ice, which for convenience is adopted as a standard."

And after discussing this proposition at some length, the law is finally stated in these words:—

"*The atomic volumes of bodies stand in a simple multiple relation to each other.*"

Series III. of these experiments is on the maximum density of water. This research was undertaken with a view to finding the best temperature at which to determine specific gravities, objection being made to the Conti-

nental standard, viz., freezing-point, and to 60° F. as generally adopted in our own country: water at 60° F. cannot be at the most desirable temperature, on account of its high rate of expansion at that point. The method employed for this determination is fully described, and after giving the results of many experiments it is finally decided that water is at its maximum density at a temperature of 39·1° F.

Series IV., on the expansion by heat of salts in the solid state, and Series V., on the disappearance of the volume of the acid, and in some cases of the base, in the crystals of highly hydrated salts, complete this valuable series of papers.

The latter part of the volume contains several papers, the joint labours of Dr. Joule and Sir Wm. Thomson, on "The Thermal Effects experienced by Air in Rushing through Small Apertures," and on "The Thermal Effects of Fluids in Motion." Mayer's hypothesis, that the heat evolved from compressed air kept at a constant temperature is the mechanical equivalent of the work done in compressing it, was verified by Joule as at least approximately true for air at ordinary temperatures, but it cannot be rigorously true except for one definite temperature. The experiments here recorded were undertaken to decide this point, but they are not considered altogether satisfactory on account of the apparatus being inadequate. If Mayer's hypothesis were true, air forced through a long pipe open wide at the end, but contracted considerably in one place, would have the same temperature after, as it had before reaching the narrow passage, but a cooling effect was always observed. Another form of contraction was tried, which consisted of a bit of calf-skin bound tightly over the end of the tube, the pores of the leather being found sufficient to allow the air to pass: as in the former case, the same cooling effect was observed, but, accidental circumstances interfering with the results, a more elaborate set of apparatus was put up, and the previous result—that air is cooled by being forced through a porous plug—was confirmed, though it was found that when issuing from a single orifice the *vis viva* of the rushing air is converted into heat.

A number of experiments are next described in which the substance used as the porous plug is changed, cotton, wool, silk, &c., being tried. Another series gives the results of substituting carbonic acid or hydrogen for air. The cooling effect experienced by hydrogen was at first found to be 1-13th of that observed with air, but subsequent experiments showed that a heating effect was obtained.

Other experiments were made, such as whirling thermometers or thermo-electric junctions through the air at a high speed, and a rise of temperature was always experienced.

The ultimate result of this research is that when the rush of the air is retarded by a porous plug, and allowed to expand, the actual temperature of that air is lower than before compression.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—What has been the outcome of all the letters which appeared in the CHEMICAL NEWS about a year ago on the above subject; and what has the Manchester Committee, of which Mr. Wm. Thompson, F.C.S., was secretary, done in the matter? I feel sure there are many who would be interested to know in addition to myself—I am, &c.,

H. M. CARRINGTON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 15, April 12, 1887.

Examination of the Alkaline Vanadates.—A. Ditte.—In this paper the author describes seven sodium vanadates, the neutral salt, $NaOVO_5$, $NaO2VO_5$, $2NaO,3VO_5$, $NaO,3VO_5$, $2NaO,VO_5$, $3NaO,VO_5$, and $4NaO,VO_5$.

No. 16, April 18, 1887.

On a Peculiar Circumstance of the Production of Sodium Hydrocarbonate.—Paul de Mondésir.—The author has observed that sodium carbonate, if combined with a single equivalent of water, absorbs carbonic acid at ordinary temperatures extremely slowly, if at all. On the contrary, if it is mixed with a small proportion of dry bicarbonate, the reaction sets in at once, and with an energy proportionate to the quantity of bicarbonate. This is a case of a solid being "primed" by a solid.

Researches on the Barium Phosphates. Application to Acidimetric Analysis.—A. Villiers.—It is known that phosphoric acid behaves with phenol-phthalein like a bibasic acid. It may be determined by a simple volumetric operation by means of a standard solution of potassa or of baryta water. In the first case there is formed an alkaline phosphate, neutral to phenol-phthalein; in the second case an insoluble barium diphosphate, and the end of the reaction is clearly indicated. Hence it seems that the acidimetric determination of an acid, such as the sulphuric, hydrochloric, acetic, &c., should be effected without difficulty, and it is in reality so if we operate with a standard solution of potassa. With baryta-water the case is different. If, after having saturated a certain volume of hydrochloric acid with baryta-water, in presence of phenol-phthalein, we add sodium diphosphate, the addition of this substance, neutral or rather slightly alkaline, to phenol-phthalein produces the same effect as the addition of an acid and a further quantity of baryta-water is necessary to effect saturation.

Method of Determining the Relative Value of the Four Units of Chemical Action of the Carbon-Atom.—Louis Henry.—The identity or the difference of value of the four units of affinity of carbon may be deduced from the nature of the monocarbides CX_4. Whatever may be the relative value of the different units of affinity, the simple monocarbide derivatives, CX_4, containing only radicles of the same sort fixed upon the carbon nucleus, must be unique, each in its species. It is thus in reality; we only know the compounds CH_4, CCl_4, CO_2, CS_2, $C(OC_2H_5)_4$, &c., under a single form; but it must be different with the mixed compounds, where different radicles are fixed upon the carbon atom. If these four units of affinity are of the same sort, and have the same value, the mixed derivatives ought to be also each unique in its species; but they ought to exist in different forms if these units of affnity are not identical. Let us take the simplest case and suppose one unit of affinity different from the three others; this being the case a double compound, CX_3X' ought to form two distinct varieties; a triple compound, $CX_2X'X''$, will form three, and a quadruple compound, $CXX'X''X'''$, will constitute four. We see the question returns to the study of isomerism in the mixed monocarbon derivatives. The author has hitherto obtained, both for acetonitrile and for nitromethane, the derivatives α, β, and γ, and he has not been able to find among these derivatives of different substitutive orders any appreciable difference.

Products of the Fermentation of Sugar by the Elliptical Yeast.—Ed. Claudon and E. C. Morin.—The authors have submitted to the action of the elliptical

yeast 100 kilos. of sugar. The yeast was obtained from the lees of a white wine of Rouillac (Charente) of the vintage of 1885. The product of the fermentation possessed a vinous odour, very distinct from the odour presented by a similar wort fermented by beer yeast. The products obtained were :—

Aldehyd	traces
Ethylic alcohol	50615·0 grms.
Normal propylic alcohol ..	2·0
Isobutylic alcohol	1·5
Amylic alcohol	51·0
Œnanthic ether	2·0
Isobutylene-glycol	158·0
Glycerin	2120·0
Acetic acid	205·3
Succinic acid	452·0

The authors call attention to the small proportion of the higher alcohols formed in this fermentation, the absence of the bases of fusel oils, as well as of normal butylic alcohol and of butyric acid.

MISCELLANEOUS.

University College, Nottingham.—At a University College Committee recently held, Professor F. Clowes, D.Sc., was unanimously appointed Principal for the ensuing year.

Electrical Communication between Lightships and the Shore.—The problem of effectually establishing electrical communication between our various lightships round the coast and the shore has, for a long time, occupied the attention of practical electricians and sailors, but for one reason or another none of the methods tried have met with success, generally owing to the electric cable fouling the mooring chains as the ship swings round with the tide. The latest scheme for effecting this communication is the one recently patented by Messrs. Little and Hale. The method adopted by them is to moor the lightship, by means of a compound universal swivel joint, to the centre-boss of a specially constructed anchor, or rather set of four mushroom anchors, whose shanks are all connected at the hub, while the outer ends are encircled by a large rim or "crinoline," the whole having somewhat the appearance of a huge massive wheel. The electric cable enters the crown of one of the mushrooms, and, passing along the shank, is led through a stuffing box to the interior of the boss, where two suitable rubbing contacts enable electrical communication to be maintained in whatever position the lightship may be, and thence through another stuffing box to the ship, without the possibility of its being fouled or twisted. The joints are made perfectly watertight by means of indiarubber packing rings, and all moving parts are bushed with phosphor-bronze. This method has the advantage of being extremely simple as well as thoroughly effective, and the inventors will no doubt have an opportunity before long of practically demonstrating the value of their invention.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Quinine Estimation.—The published processes, as far as I am acquainted with them, are unsatisfactory. I should be glad to be informed of the methods used by quinologists of assaying cinchona bark. Does the quinine in their reports include amorphous as well as crystallisable alkaloid ?—Puzzled.

Watermark in Paper.—There is no satisfactory chemical method of putting a watermark into paper after manufacturing. It must be done by a mechanical process; *e.g.*, imitation watermarks may be made in paper by pressure upon a marked plate in which the watermark is raised. Of course they cannot be made as permanent as the real mark, as in that case the paper is thin under the mark.—J. H. Swindells.

MEETINGS FOR THE WEEK.

Monday, 9th.—Society of Arts, 8. (Cantor Lectures). "The Chemistry of Substances taking part in Putrefaction and Antisepsis," by J. M. Thomson, F.C.S.
Tuesday, 10th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
—— Royal Institution, 3. "Electricity," by Prof. W. E. Ayrton, F.R.S.
—— Society of Arts, 8. "The Architecture of London Streets," by E. J. Tarver, F.S.A.
Wednesday, 11th.—Society of Arts, 8. "Cottage Industries in Ireland," by Mrs. Ernest Hart.
—— Geological, 8.
—— Microscopical, 8.
Thursday, 12th.—Royal, 4.30.
—— Telegraph Engineers, 8.
—— Royal Institution, 3. "The Chemistry of the Organic World," by Prof. Dewar, F.R.S.
Friday, 13th.—Royal Institution, 9. "Some Electrical Fishes," by Prof. J. S. Burdon Sanderson, M.D., F.R.S.
—— Quekett Club, 8.
Saturday, 14th.—Royal Institution, 3. "Victorian Literature," by Prof. John W. Hales, M.A.
—— Physical, 3. "A Modification of a Method of Maxwell's for Measuring the Coefficient of Self-Induction." by Mr. Ernest C. Rimington. "Note on Transformers for Electrical Distribution," by Prof. S. P. Thompson, D.Sc.

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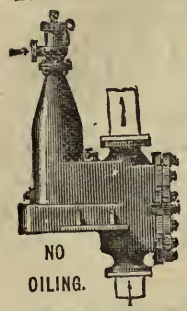

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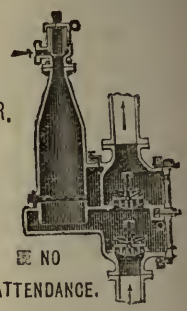

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4	160	12 0 0	18 0 0	23 0 0
5	250	15 0 0	22 10 0	31 0 0
6	320	18 0 0	..	..
7	400	21 0 0	.	..
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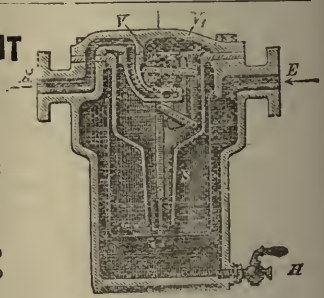

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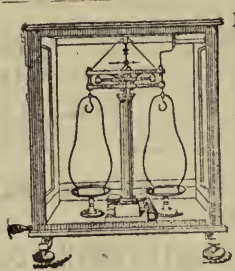

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THE CHEMICAL NEWS.

VOL. LV. No. 1433.

ON AUSTRALIAN BAT GUANO AND SOME MINERALS OCCURRING THEREIN.

By R. W. EMERSON MACIVOR, F.I.C., F.C.S., F.R.G.S., &c.,
Late "Clarke" Lecturer on Agricultural Chemistry, Victoria, and Principal of the Department of Agriculture, Technical College, Sydney, N.S.W.

IN caves situated in different parts of Victoria there exist more or less extensive deposits of guano, which are generally believed to have been formed from the excrements and other remains of bats. Some of these accumulations have little or no commercial value, while in others the guano contains sufficient nitrogen and phosphoric acid to entitle it to rank with useful fertilisers. The following are analyses of some inferior qualities :—

	Hamilton.	Portland.	Warrnambool. (1).	Warrnambool. (2).
Water	35·71	19·97	20·30	37·48
Organic matter ..	33·77	41·33	8·95	18·30
Ash	30·52	38·70	70·75	44·22
	100·00	100·00	100·00	100·00
Total nitrogen ..	1·08	1·28	0·91	1·89
Phosphoric acid..	2·41	11·88	7·45	9·98

The samples from Hamilton and Portland fairly represented the average of the contents of the caves. In the case of the Warrnambool guano the first sample was taken from near the surface at the entrance of the cave, and the second from a depth of four feet in the centre of the deposit in the same cave. This guano, as obtained from the depth mentioned, has distributed throughout its mass, though only very sparingly, minute glistening particles of a mineral presently to be noticed, viz. *Newberyite*.

But the only important deposits of bat guano yet discovered in Australia are those in the Skipton caves on the estate of the Hon. Francis Ormond, about thirty miles south-west of the city of Ballarat. The bottom of each of these extensive basaltic caverns is covered with the guano to a depth of thirty feet in some places, and the origin of the deposits is pretty well indicated by the fact that until lately myriads of bats made the caves their home during daylight, and could be seen hanging in countless clusters from the roof.

The Skipton guano varies very much in appearance and composition. In the older and drier deposits it is light brown in colour, nearly odourless, and contains white nodular phosphate of magnesium and ammonium disseminated throughout its body together with fine colourless or slightly tinted prismatic crystals of the mineral which I in 1878 named *Hannayite*—

$$[Mg_2H_2(PO_4)_2.MgH_2(NH_4)_2(PO_4)_2+8H_2O]$$

in honour of my friend Mr. J. B. Hannay, and rhombic crystals of another mineral which I in the same year called *Newberyite* $[Mg_2H_2(PO_4)_2+6H_2O]$ in compliment to Mr. J. Cosmo Newbery, C.M.G., the well-known Australian chemical authority. The great bulk of these deposits, however, consists of dark brown or brown-black guano containing so much water that when dug out it comes away in lumps, whereas the older deposits are powdery. This moist, or I should say wet, material is thickly studded with large and often perfect crystals of *Struvite* $[Mg_2(NH_4)_2(PO_4)_2+12H_2O]$.

In the following table I have arranged some analyses of Skipton guano after the removal of all crystals of the minerals mentioned :—

	I.	II.	III.	IV.	V.
Water	16·74	30·52	30·95	33·50	44·50
Organic matter ..	22·00	44·98	31·21	44·66	32·60
Ash	61·26	24·50	37·83	21·84	22·90
	100·00	100·00	100·00	100·00	100·00
Total nitrogen ..	2·40	4·51	5·05	6·95	3·8
Nitrogen as nitric acid	0·39	0·87	1·26	1·34	0·46
Phosphoric acid, P_2O_5..	7·64	4·10	10·87	3·61	7·80

I. Sample was light in colour and contained neither *Struvite* nor *Hannayite*, but only *Newberyite*, and amorphous phosphate of magnesium and ammonium.

II., III., and IV. Samples had a rich brown colour, and contained much *Struvite* and also some *Hannayite*. *Newberyite* was absent in each case.

V. Sample was brown-black, and full of *Struvite*, but neither of the other minerals was present. All the samples contained nitrates. The ash was found to contain only traces of sulphate and carbonate of calcium, and to be composed of siliceous matter, oxide of iron, traces of manganese, phosphates of magnesium and calcium, chloride of sodium, and a little potassium.

When treated with water the guano gives up a considerable part of its phosphoric acid and nitrogen, together with organic matter, yielding a dark brown solution. This solubility indicates the fitness of the manure for top-dressing grass-land and young cereals, and extensive field trials made under my direction in various parts of the colony gave eminently satisfactory results. If any objection could be urged against the guano, it would be on the score that its first effect on tender plants is of a "too forcing" character.

Turning from the consideration of the guano to the minerals that occur in it, I may mention that the crystallographic characters of *Struvite*, *Hannayite*, and *Newberyite* have been most minutely examined by Professors vom Rath, of Bönn, and G. Ulrich, of the University of New Zealand, to both of whom I sent some excellent specimens. The results obtained by these gentlemen are to be found in the latest edition of Dana's "Mineralogy, so that I need not here further refer to them.

Struvite.—Analyses of this mineral have already been published by Ulex and by J. C. Newbery, but the following results may not be wholly uninteresting :—

	Found.	Theory.
Magnesium oxide.. ..	16·069	16·327
Ferrous ,, ...	0·810	—
Manganous ,, ...	0·163	—
Ammonium ,, ...	10·567	10·612
Phosphoric ,, ...	28·819	28·980
Water (as difference) ..	43·572	44·081
	100·000	100·000

When exposed for a long time to the air crystals of struvite lose some of their water of crystallisation, and become thinly coated with a white powder. The nodular phosphate of magnesium and ammonium in the guano of the older deposits is in my opinion only altered struvite

Hannayite.—Crystals of *Hannayite* do not lose water by exposure to the atmosphere or to a temperature of 100° C. At 110° to 115°, however, they give up about two-thirds of their water of crystallisation, and lose their transparency. When heated over a Bunsen the crystals swell considerably, become opaque, and ultimately assume peculiar "maggot-like" forms. The residue is soluble in nitric acid, but only partially in hydrochloric acid, proving it to contain pyro- and meta-phosphates of magnesium—

$$Mg_2H_2(PO_4)_2.MgH_2(NH_4)_2(PO_4)_2 = Mg_2P_2O_7+Mg(PO_3)_2+2NH_3+2H_2O.$$

The crystals of this mineral are frequently found adhering to those of *Struvite* in such a way as almost to in-

dicate that they had been formed from the latter. Further, I may mention that *Hannayite* occurs most abundantly in guano containing the nodular double phosphate already referred to, and no distinct crystals of *Struvite*. The following is an analysis of *Hannayite*:—

	Found.	Theory.
Magnesium oxide.. ..	18·545	18·869
Ferrous ,, ...	0·310	—
Manganous ,, ...	0·087	—
Ammonium ,, ...	8·095	8·176
Phosphoric ,, ...	44·711	44·654
Water (as difference) ..	28·252	28·301
	100·000	100·000

Newberyite.—It is extremely difficult to free this mineral from the guano that exists locked up in the body of the crystal. However, I succeeded in getting a sufficient quantity of pure substance to make an analysis:—

	Found.	Theory.
Magnesium oxide.. ..	22·368	22·988
Ferrous ,, ...	0·850	—
Manganous ,, ...	0·206	—
Phosphoric ,, ...	40·728	40·805
Water (as difference) ..	35·838	36·207
	100·000	100·000

The crystals do not part with water at 100° C., but lose the whole six molecules at about 170° C., and on ignition leave pyrophosphate only.

I may, in conclusion, mention that two other phosphates of magnesium and ammonium new to science exist in Skipton guano, and these I have named *Muellerite* and *Dittmarite* respectively. I propose to make these minerals the subject of a future paper.

SHORT TITLES OF CHEMICAL PERIODICALS CURRENT IN 1887.

By H. CARRINGTON BOLTON.

[For full titles and bibliographical details see "*Catalogue of Scientific and Technical Periodicals*, 1665—1882," by Henry Carrington Bolton, Smithsonian Institution, Washington, 1885, pp. x—774, 8vo.]

Agenda du chimiste. Paris. (Established in 1877.)

American Chemical Journal, Edited by Ira Remsen. Baltimore. (Established in 1879.)

American Chemical Review. Chicago. (Established as Chemical Review in 1881.)

Analyst (The), including the Proceedings of the "Society of Public Analysts." London. (Established in 1876.)

Annalen der Chemie (Justus Liebig's). Leipzig. (Established in 1832 as Annalen der Pharmacie.)

Annalen der Physik und Chemie. Wiedemann. Leipzig. (Established by Poggendorff in 1824.)

Annales de chimie et de physique. Paris. (Established in 1789 as Annales de chimie.)

Annali di chimica medico-farmaceutica. Milano. (Established in 1824 by Cattaneo as Giornale di farmacia, chimica e scienze accessorie.)

Beiblätter zu den Annalen der physik und Chemie. Wiedemann. Leipzig. (Established in 1877.)

Berichte der deutschen chemischen Gesellschaft. Berlin. (Established in 1868.)

Biedermann's Centralblatt für Agrikulturchemie. Leipzig. (Established in 1872.)

Bulletin de l'association des chimistes de sucrerie et de distillerie de France et des colonies. 8vo. Paris. (Established in 1883.)

Bulletin de la Société chimique de Paris. Paris. (Established in 1858.)

Bulletin of the Chemical Society of Washington. Washington. (Established in 1886.)

Chemical News (The). William Crookes. London. (Established in 1860.)

Chemical Review (The). London. (Established in 1871.)

Chemiker (Der) und Drogist. Leipzig. (Established in 1885.)

Chemiker-Kalender. Biedermann. Berlin. (Established in 1880.)

Chemiker-Zeitung. G. Krause. Cöthen. (Established in 1877 as Allgemeine C.-Z.)

Chemische Industrie (Die). Jacobsen. Berlin. (Established in 1878.)

Chemisches Centralblatt. R. Arendt. Leipzig. (Established in 1830 as Pharmaceutisches Centralblatt.)

Chemisch-technischen Mittheilungen (Die) der neuesten Zeit. Elsner. Berlin. (Established in 1846.)

Chemisch-technischer Central Anzeigen. Leipzig. (Established in 1883.)

Chemisch-technishes Repertorium. Jacobsen. Berlin. (Established in 1862.)

Chemist (The) and Druggist. London. (Established in 1859.)

Comptes rendus hebdomadaires des sèances de l'Académie des Sciences. Paris. (Established in 1835.)

Deutsche Chemiker-Zeitung. Berlin. Established in 1886.)

Fortschritte (Die) der Chemie. From Vierteljahres-Revue der Naturwissenschaften. Köln. (Established in 1879.)

Gazzetta chimica italiana. Paterno. Palerma. (Established in 1871.)

Giornale di farmacia, chimica e di scienze affini. Chiappero. Torino. (Established in 1852.)

Jahrbuch der Erfindungen und Fortschritte auf den Geibieten der Physik und Chemie. Leipzig. (Established in 1865.)

Jahresbericht über die Fortschritte auf dem Gesammtgebiete der Agriculturchemie. Berlin. (Established in 1858 by Hoffmann.)

Jahresbericht über die Fortschritte der Chemie and verwandter Theile anderer Wissenschaften. Fittica. Giessen. (Established in 1847 by Liebig and Kopp.)

Jahresbericht über die Fortschritte der Thierchemie. Maly. Wien. (Established in 1871.)

Jahresbericht über die Leistungen der chemischen Technologie. Fischer. Leipzig. (Established by Wagner in 1855.)

Journal de pharmacie et de chimie. Paris. (Established in 1809 as Bulletin de pharmacie.)

Journal für praktische chemie. Neue Folge. E. von Meyer. Leipzig. (Established in 1798 as Allgemeines Journal der chemie.)

Journal (The) of Analytical Chemistry. Hart. Easton, Pa. (Established in 1887.)

Journal of the American Chemical Society. New York. (Established in 1876.)

Journal of the Chemical Society [of London]. London. (Established in 1841.)

Journal (The) of the Society of Chemical Industry. London. (Established in 1882.)

Meddelelser fra Carlsberg laboratoriet. Christiania. (Established in 1884.)

Mélanges physiques et chimiques tirés du Bulletin phys. math. de l'Académie Impèriale de St. Pétersbourg. St. Pètersbourg. (Established in 1846.)

Mittheilungen aus der amtlichen Lebensmittel-Untersuchungs-Anstalt * * * zu Wiesbaden. Berlin. (Established in 1885.)

Monatshefte für Chemie * * * aus der Sitzungsberichte der K. Acad. Wiss. Wien. (Established in 1880.)

Moniteur (Le) des produits chimiques. Paris. (Established in 1871.)

Moniteur Scientifique Quesneville. Paris. (Established as Revue scientifique by Quesneville in 1840.)

Orosi (L'), Giornale di chimica. Firenzi. (Established in 1878.)

Ragguagli. Laboratorio chimico-agrario di Perugia. Perugia. (Established in 1883.)

Recueil des travaux chimiques des Pays-Bas. Leide. (Established in 1882.)

Répertoire de pharmacie et Journal de chimie médicale. (Established in 1844.)

Repertorium der analytischen Chemie für Handel, Gewerbe, [etc.] Skalweit. Hamburg. (Established in 1881.)

Revue des industries chimiques et agricoles. Paris. (Established in 1878.)

Skandinavians kemisk-tekniske Centalblad for Danmark, Sverige, Norge og Finland. Kjöbenhavn. (Established in 1882.)

Supplemento annuale alla enciclopedia di chimica. Dal I. Guareschi. Torino. (Established in 1884.)

Technisch-chemisches Jahrbuch. Biedermann. Berlin. (Established in 1880.)

Tidsskrift for Physik og Chemi. Thomson. Kjöbenhavn. (Established in 1862.)

Tokyo Kagakkai Kaishi. J. Sakurai. Tokyo. (Established in 1880.) [Journal of the Tokyo Chemical Society.]

Vierteljahresschrift über die Fortschritte auf dem Gebiete der Chemie der Nahrungs- und Genussmittel. Berlin. (Established in 1886.)

Zeitschrift für analytische Chemie. Fresenius. Wiesbaden. (Established in 1862.)

Zeitschrift für die chemische Industrie. Fischer. Berlin. (Established in 1887.)

Zeitschrift für physiologische Chemie. Hoppe-Seyler. Strassburg. (Established in 1877.)

Zeitschrift für physikalische Chemie. W. Ostwald. Riga, 1887.

Zhurnal russkova khimicheskova i fizicheskova. St. Petersburg. (Established in 1869.)—*Journal of Analytical Chemistry*, Vol. i., Part 2, April, 1887.

REMARKABLE SPECIFIC GRAVITY OF LIME-WATER.

By J. ALFRED WANKLYN.

I have recently had occasion to take the specific gravity of lime-water, and have noted a peculiarity which appears to me to be of very great interest. According to a recent determination in my laboratory a litre of lime-water contains 1·344 grms. of CaO, and the specific gravity of the lime-water reaches the extraordinary figure 1002·35, compared with distilled water at the same temperature, reckoned as 1000·00 (the temperature was 13° C.).

It follows from these observations that in the formation of lime-water a most extraordinary contraction takes place.

Before solution :—

CaO	0·5 c.c. =	1·344 grms.
H_2O	1001·0 ,, =	1001·0 ,,

which contract so as to occupy one litre.

The contraction is, therefore, three times the volume of the lime which dissolves in the water and forms lime-water.

The purity of the lime-water was ascertained by exactly precipitating the lime by means of its equivalent of oxalic acid, filtering, and evaporating the filtrate to dryness; the residue was so small as to be insignificant.

Royal Institution of Great Britain.—Mr. John W. Hales, Professor of English Literature at King's College, will give the first of a Course of four lectures on Victorian Literature at the Royal Institution, on Saturday, May 14; and Mr. Victor Horsley, F.R.S., will give the first of a Course of three lectures on The Modern Physiology of the Brain and its Relation to the Mind, on Tuesday, May 17.

THE HARDNESS OF METALS.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S., Lecturer on Metallurgy, Mason College, Birmingham.

(Concluded from p. 207.)

Part III.

It now remains to give an account of some results obtained by the form of instrument just described. It was thought it would be of interest in the first place to approximately calibrate the apparatus by comparison with a few substances of known hardness. Dr. Lapworth was good enough to select a few minerals for me, the specimens being considered pretty characteristic. Each specimen was examined on more than one face, and in two directions, at right angles to each other, on each surface. The values given therefore approximately represent the mean hardness of the specimens examined. In calcite considerable differences were noticed in the hardness of the faces employed. A few common metals were also tested, and for comparison several varieties of iron and steel are added, the results being given in Table A. It may be mentioned that my present apparatus was designed for use with cast-iron, and hence in the lower numbers the percentage error is probably greater than in the cases when 20 grms. or upwards was employed. I am hoping, however, shortly to have a modified instrument for softer substances, with which to carry on the investigation, and to examine various alloys used in the arts.

An examination of Table A shows that the weights used correspond closely in order with what might be anticipated from the hardness according to Moh's scale. The values obtained for the various minerals are considerably higher than those given by Franz, but, as previously shown, this, in all probability, depends on a different method of observation.

Table A.

Substance.	Moh's scale.	Weight in grms.
Steatite	1	1
Lead (commercial)	1½	1
Tin lead alloy (66% Sn)	—	2
Tin (commercial)	2	2½
Rocksalt	2	4
Zinc (pure, annealed)	2½	6
Copper (pure, annealed)	2½	8
Calcite	3	12
Softest iron tested	—	15
Fluor-spar	4	19
Mild steel usually	4—5	21
Tyre steel	4—5	20—24
Good soft cast-iron	4—5	21—24
South Staffordshire bar iron	4—5	24
Apatite	5	34
Hard cast scrap	—	36
Window glass	5—6	60
Hardest cast-iron tested	—	72

In Table B are reproduced my original experiments on the hardness of cast-iron as affected by the addition of silicon to white iron. (*Jour. Chem. Soc.*, 1885, p. 904). The effects here observed have recently been largely applied in England, Scotland, France, and elsewhere, in the production of a soft iron, with considerable tenacity, by the addition of silicon to a hard material, and already many thousands of tons of castings have been successfully prepared in this manner. An examination of Table B shows that the hardness as observed by means of a weighted diamond agrees very closely indeed with the working qualities, as given by an experienced workman. Further it will be seen that the tensile strength and hardness do not agree, but appear to follow almost in inverse order. These facts prove conclusively that *the method employed is capable of distinguishing between tenacity and hardness.*

* Read before the Birmingham Philosophical Society, Dec 9, 1886,

TABLE B.

Influence of Silicon on the Hardness and Tenacity of Cast Iron.

Nos	Silicon per cent.	Tensile Strength.	Hardness.
1.	0·19	10·14 tons	72
2.	0·45	12·31 ,,	52
3.	0·96	12·72 ,,	42
4.	1·96	15·70 ,,	22
5.	2·51	14·62 ,,	22
6.	2·96	12·23 ,,	22
7.	3·92	11·28 ,,	27
8.	4·75	10·16 ,,	32
9.	7·37	5·34 ,,	42
10.	9·80	4·75 ,,	57

Working Qualities.

No. 1.—Very hard indeed.
,, 2.—Very hard, though not so hard as No. 1.
,, 3.—Hard, though softer than No. 2.
,, 4.—Good, sound, ordinary, soft-cutting iron, of excellent quality.
,, 5.—Rather harder than No. 4.
,, 6.—Like No. 4.
,, 7.—Like No. 6, but rather harder.
,, 8.—Rather harder than No. 7, though not unusually hard.
,, 9.—Still harder, cutting very like No. 10.
,, 10.—Hard-cutting iron, though still softer than No. 1.

TABLE C.

Cast-Iron Specimens at Rosebank Foundry.

No.	Tensile Strength.	Relative Hardness.
1	18·2	24
2	17·1	24
3	17·0	24
4	16·8	20
5	16 4	28
6	14·7	46
7	14·2	25
8	13·0	21
9	13	21
10	13	39
11	13	42
12	12¼	18
13	12¼	18
14	12¼	21
15	12	35
16	11¾	49
17	10½	18
18	9¼	42
19	8¼	25
20	8	25
21	7·8	21
22	6·5	25
23	6·5	25

In Table C are given the results of other experiments on the hardness of cast-iron, conducted last summer at the Rosebank Foundry, Edinburgh. The first four specimens have been preserved, and have been recently re-examined. In the other cases, however, the experiments were conducted in a room with unfavourable light, and with an apparatus which has been since improved. Had opportunity offered, therefore, these specimens would have been tested again, but unfortunately they were destroyed at the works soon after our experiments were finished. The numbers are, therefore, probably not so rigidly exact as in other cases, though, doubtless, quite sufficiently near to be of practical value. In his table we have a large number of specimens purposely selected so as to embrace as wide a range in tenacity as possible, and including, I believe, in the first five specimens, the highest recorded tensile strengths for British cast-iron. It will be seen that we have practically the same hardness with the highest as with the lowest tensile strength, and that in this case also no definite connection can be shown to exist between hardness and tenacity. Founders are usually of opinion that cast-iron can be made strong if it is made sufficiently hard. This is merely an old superstition, and the sooner it is exploded and forgotten the better for all concerned. So far as my experience has gone, it is quite the contrary. As a matter of fact, specimens with exceptionally high tensile strength are almost always good soft working irons; while special softness or unusual hardness is generally a sign of weakness.

TABLE D.

Purest Bessemer Metal, with Small Quantities of Silicon Added.

No.	Tensile Strength.	Elongation per cent on 10 inches.	Hardness.
1	21·80	24·7	18
2	20·72	19·5	16
3	22·60	15·4	17
4	23·18	15·	17
5	24·23	24·0	20
6	27·45	12·8	21
7	25·77	22·0	20
8	21·89	24·2	15

Leaving cast-iron, we come to the consideration of the various varieties of soft steel. In Table D we have the results obtained with the purest iron obtainable in commerce, namely, that in the Bessemer vessel at the end of the blow, and before any addition has been made. This was mixed with small but gradually increasing quantities of silicon pig, and the product examined. The specimens have not yet been completely analysed, but they are arranged in order of silicon, beginning with a trace and ending with about 0·2 per cent. I hope shortly to publish full details (these have since been published *Journ. Chem. Soc.*, Feb., 1887). On comparing the hardness with tensile strength it will be seen that they vary together in a remarkable manner, the effect being entirely unlike that noticed in cast-iron. The fact that the material operated upon was a very near approach to homogeneous metal confirms the statement made in Part I. that in such material tenacity and hardness vary together. The results also appear to afford a proof of the correctness of the principle adopted in these experiments, as the values vary in different materials in a manner such as would be anticipated on theoretical grounds.

In Table E are given the results obtained in the case of four specimens of tyre steel, of which the analyses are given, but of which the tensile strength was not ascertained. It will be seen that they agree very nearly in chemical composition, and the hardness varies only from 21 to 24, which is about the ordinary limits for such material.

TABLE E.

Tyre Steel—with Analyses.

No.	C.	Si.	Mn.	S.	P.	Hardness.
1	0·58	0·23	0·64	0·03	0·03	24
2	0·59	0·40	0·63	0·04	0·07	23
3	0·52	0·23	0·61	0·01	0·06	21
4	0·62	0·15	0·57	0·01	0·04	22

I have also examined a number of specimens forwarded to me by Professor Kennedy, of University College, London. They were selected about three years ago for another purpose, for which, however, they were not employed. The results are given in Table F. The tensile strength and extension were measured by Professor Kennedy, and are given for comparison. The specimens varied in tenacity from about 29 to 46 tons per square inch, and include specimens ranging from the soft steel for boiler plates, up to the moderately hard metal used for tyres or rails.

It will be seen that the hardness is remarkably uniform throughout, and though there is a tendency for specimens with higher tensile strength to be slightly harder, still several exceptions will be found to this.

TABLE F.

Steel Specimens from Professor Kennedy.

University College No.	Material.	Breaking load Tons per sq. in.	Extension per cent On 2 ins.	Relative Hardness.
4684	Steel rail	40·87	18·5	23
4914	Steel Waggon Tyre	42·30	25·0	24
4936	Bessemer Steel	42·56	20·0	21
4081	Steel Fish Plate	45·13	25·5	22
5013	Steel Tyre	45·94	20·5	22
			On 3 inches.	
5073	Steel Tyre	36·93	20·7	21
5077	,,	37·13	24·7	23
5072	,,	38·63	24·7	21
5071	,,	40·70	17·3	21
5074	,,	40·89	25·0	21
5078	,,	41·17	23·7	21
			On 7 inches.	
1284	Bessemer Steel Tyre	31·31	22·9	21
1283	,,	34·65	18·4	22
1298	,,	35·79	16·1	21
1297	,,	35·92	18·3	20
1256	,,	36·14	18·1	22
			On 10 inches.	
2753	Steel Boiler Plate	29·09	22·7	21
2752	,,	29·36	25·0	24
2751	,,	29·53	24·0	21
2732	,,	30·95	18·8	21

Allowance must of course be made for the probable experimental error of about ± 5 per cent.; but even then no direct connection between hardness and tenacity can be traced in this series of experiments. This would appear to point to the conclusion that in tyre steel, and similar material, we have not a homogeneous and structureless material, as in the case of nearly pure iron, but that the metal has more or less internal structure, possibly crystalline, which causes the hardness and tenacity not to vary together, as noticed in certain other cases.

TABLE G.

Mr. J. T. Smith's Experiments on Steel Rails.
(Inst. C.E., xlii., p. 74.)

No.	Strain required to punch a hole ⅞ in. diameter through web ¾ inch thick.	Tensile strength. Tons per sq. inch.	Carbon per cent.
1	46·25	30·91	0·28
2	46·33	30·08	0·28
3	46·97	31·03	0·28
4	47·18	31·56	0·28
5	48·21	31·53	0·29
6	48·27	32·85	0·30
7	48·50	33·37	0 30
8	48·86	33·07	0·29
9	48·89	31·88	0·31
10	49·00	32·33	0·29
11	49·00	33·37	0·31
12	49·07	32·09	0·30
13	49·41	31·97	0·32
14	49·50	32·75	0·31
15	49·68	33·18	0·29
16	50·00	33·59	0·30
17	50·11	33·08	0·30
18	50·27	32·67	0·30
19	51·05	33·65	0·32
20	52·50	33·49	0·32
21	56·79	37·01	0·36
22	58·16	37·42	0·40
23	58·44	37·93	0·40
24	61·24	41·41	0·39
25	61·34	39·10	0·43
26	64·42	42·82	0·44
27	65·19	44·00	0·45
28	65·31	39·23	0·44
29	74·50	45·79	0 50
30	82·47	50·42	0·57

A very interesting series of experiments on the conditions affecting the wear of steel rails is recorded in a paper by Mr. J. T. Smith (*Inst. C.E.*, 1875, xlii., p. 69). Extracts from these results are given in Table G, from which it will be seen that "hardness" was measured by the force required to punch a hole ⅞ of an inch in diameter, through a web of metal ¾ of an inch in thickness. It will be seen from the table that the tensile strength increases very regularly as the proportion of carbon becomes greater, and that the "hardness" increases with equal regularity, and in the same manner. This appears to strongly support my contention, that the force required to make a measurable indentation will depend very greatly upon the tenacity of the material. It was found contrary to what was anticipated, that the "softest" rails generally wore best. This observation is supported by Dr. Dudley* and other writers of experience, though contested by some authorities. If the results of Mr. Smith's experiments are graphically represented (*Inst. C.E.*, xlii., p. 90), it is found that the curves of percentage of carbon, and the punching, tensile, and bending tests are of the same general form, and show a close agreement. The curve of percentage of wear, however, does not agree with these, but is quite irregular, and the differences observed in this respect are not so great as might have been expected from the other tests. It would appear from this that in the softer classes of steels, when not hardened by rapid cooling, the so-called "hardness," due to carbon, is really in a great measure due to tenacity, and that when correctly measured, the true hardness of this class of material does not usually vary over very wide limits. To me it appears probable that the best rails to wear would be those in which true hardness and tenacity are both high, while the material is not so altered as to render it too sensitive to sudden shock. Internal structure doubtless also has a most important influence.

Mr. Smith's experiments appear to conclusively prove the unreliability of the method of indentation as a measure of hardness, while his observations on the wear of this class of material fully support the results given in Table F, in which it is shown that the hardness varies within narrow limits, and does not differ much from that of good wrought-iron, or of soft cast-iron of good quality.

From these observations I am inclined to suggest the following values as results which may be anticipated from an apparatus like my own, used in the manner described:—

Material.	Hardness.
Extra pure iron, tensile strength, 22 tons ..	17
Soft and weak cast-iron	18
Mild steel, tensile strength, 30 tons	21
Tyre steel ,, ,, 40 ,, ...	21—24
Cast-iron, maximum tensile strength	21—24
Iron for rolls about..	30
Hard scrap about..	40
Very hard white iron about..	70

Here the matter must be left for the present, but at a future time I hope to pursue these investigations further.

THE AMSTERDAM EXHIBITION OF FOOD AND COOKERY.

GREAT preparations are being made in Amsterdam for the Exhibition of articles of food and cookery, which is to be opened in that city in June next. Much interest in the Exhibition has been excited not only in Holland, but in Germany, Belgium, and France. A number of exhibitors are coming from England. The object of the Exhibition is to extend the knowledge of the various vegetable and animal kinds of nourishment provided by nature for the benefit of man; to furnish by mutual comparison a stimulus to further improvement, both in the cultivation and preparation of these articles; and at the same time

* Compare Snelus. *Jour. Iron and Steel Inst.*, 1882, ii., pp. 585, 596.

to disprove in the most convincing way the prejudices which too often prevent or hamper the general introduction of useful means of nourishment. A feature of the Exhibition, which partakes of a philanthropic character, is the fact that the promoters are not pecuniarily interested in the concern. Their idea is the introduction into Holland of articles which other countries manufacture, and the Dutch people might use. It is believed that there is a large market for English goods yet to be opened in Holland. The reason why there is at the moment so limited a hold on the Dutch market, is that almost all goods imported reach the retailer through the hands of middlemen. There is little doubt that English wares are not of themselves too dear for Holland. With a view to encouraging the presence of British exhibits, not only has the cost of space been reduced, but the railway and steamer rates have been greatly lowered. It has also been provided that no Customs' duties shall be charged. Other considerable facilities are announced in addition. Part of the Exhibition grounds will be fitted up as a seventeenth century town-hall market-place, fish-market, &c., and a large square will be set apart for concerts and entertainments of a varied character. In the evening there will be fireworks as at our own Inventions Exhibition. The Exhibition will remain open from June till September. The classes of exhibits range under eight chief groups,—animals and plants, living or fresh, supplying articles of food; articles of food in raw or partially prepared condition; articles of food ready for use; malt liquors, mineral and aërated waters, fruit juices, lemonades, &c.; appliances used in the manufacture, preservation, and transport of the articles; appliances for analysing and testing articles of food, beverages, &c.; articles of food prepared in the kitchen for immediate use; dining rooms (penny dinners), modes of serving up food, crockery, table linen, lamps, cutlery, &c., &c. A separate catalogue is devoted to the exhibits coming under the head of agriculture and horticulture. There will be a series of competitions, for which gold medals and prizes of five hundred francs are to be given; also a series of exhaustive lectures on cookery. Applications for space are to be sent in immediately.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, May 5th, 1887.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. T. Cooksey, George Robertson, David Wilson, Jun., and George Collar were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Hugh Barclay, Rose Hill, Harrington, Cumberland; John Edward Green, 68, Portland Road, Holland Park, W.; William Marshall, 7, Walter Street, Nottingham; Frederick Lawrence Overend, B.A., Blair Lodge School, Polmont, N.B.; J. Stanley Phillips, Wentworth, Upper Long Ditton, Surrey; Walter Shelley Spencer, 142, Clifton Street, Brooks Bar, Manchester; Charles Ernest Stedman, Williamstown, Melbourne.

The following papers were read:—

41. "*A Contribution to the Study of Well Water.*" By R. Warington, F.R.S.

The proportion of chlorine in the rain water at Rothamsted is 2 per million; the proportion of total combined nitrogen about 0·7 per million.

Of 31 inches of rain, annually falling on a bare clay soil, 17 inches have evaporated and 14 inches percolated below 5 feet. Drainage chiefly occurs between October and February. The quantity of chlorine in the drainage from 5 feet of soil is the same as that in the rain, but the proportion is doubled in consequence of evaporation. The proportion of nitrogen as nitrates in the drainage water from 5 feet of bare clay soil has averaged 10·7 per million. The production of nitrates in the soil is chiefly during summer; the principal discharge of nitrates as drainage is in the autumn.

When land is covered with vegetation evaporation is increased, and the winter drainage commences at a later period. Evaporation being increased, the chlorine in the drainage water may also be increased. The drainage from the Rothamsted unmanured wheat land contains 6 per million of chlorine; the drainage from the plot manured with farmyard manure, 7·3 per million. While vegetation is active no nitrates are found in the drainage water from the unmanured wheat; the nitrates reappear in autumn, after harvest. The average proportion of nitrogen as nitrates in the drainage from unmanured wheat is 3·4 per million; from wheat receiving farmyard manure, 5·8 per million. These are minimum numbers. With rain containing the amount of chlorine found at Rothamsted, the average proportion of chlorine in drainage water can hardly exceed 8 per million.

The pure well waters of Harpenden contain a minimum of 4·4 of nitric nitrogen per million; this, therefore, is the average amount in the drainage water of the district.

The deep wells in the chalk of Harpenden derive their main supply from a flow of underground water proceeding from north-west to south-east. Each well has besides its own local drainage. The pure well waters contain about 11 per million of chlorine; this amount does not sensibly vary throughout the year. Wells contaminated by sewage are generally at their maximum purity in October. They may show a commencement of a rise in chlorides one or two months after active autumn drainage has commenced. All through the drainage season, the effect of one month's drainage is not manifested in the well water till the following month. The maximum of chlorides in the contaminated wells occurs after the end of the drainage season—usually in March. The nitrates and chlorides increase at a nearly equal rate during the early months of the drainage season. If active drainage continues for three months, a great increase in the proportion of nitrates will usually then take place, and this relative excess of nitrates is maintained for some months. The proportion of nitrates to chlorides varies considerably in different contaminated wells. The sewage for poorly fed population yields a high proportion of chlorides to nitrates. Stable sewage furnishes apparently a high proportion of nitrates to chlorides. The old sewage contamination of deep wells is generally more or less chloric, chlorides being more permanent than nitrates.

The well waters of Harpenden contain the nitrifying organism in small proportion; it is probably derived from surface soil which has fallen in.

In the contaminated waters the quantity of silica is not increased, and the quantity of carbonates but little increased. Lime is considerably increased, and magnesia still more. Nitrates, chlorides, and sulphates are largely increased.

On comparing the low proportion of chlorine found in the pure chalk waters of Harpenden, near the edge of the London basin, with the amount found in other chalk waters, and especially with the chalk waters beneath the London clay,—and considering further the proportion of chlorides which can possibly be contributed by rain,—it appears highly probable that a portion of the chlorides in chalk water, and probably in the water of other strata, is derived from a residue of sea-salt remaining in the rock.

The proportion of nitrates found in the waters of uncontaminated wells and springs in the permeable strata of England is fairly constant; it indicates an average loss to the soil of about 7 lbs. of nitrogen per acre per annum.

42. "*Crystals in Basic-Converter Slag.*" By J. E. Stead and C. H. Ridsdale.

The authors describe a variety of crystals found near the centre of blocks of basic-converter slag, weighing 40 to 50 cwts. each, which had cooled slowly.

No. 1. Large, well-formed, flat square crystals, of a faint yellowish colour, consisting essentially of the phosphate $4CaO \cdot P_2O_5$; these have also been described by Hilgenstock.

No. 2. Blue crystals, previously noticed by Gioddeck and Brockmann; these appear to be a double calcium silicate and phosphate, $CaO \cdot P_2O_5, CaO \cdot SiO_2$. Vanadium protoxide was present to the extent of 1·64 per cent.

No. 3. Feathery or fern-like crystals; these are remarkable, as they contain under 4 per cent of acid oxides and over 95 per cent of basic oxides—chiefly of calcium, magnesium, iron (protoxide and peroxide), and manganese.

No. 4. Hexagonal, needle-shaped, lemon-coloured crystals, which appear to consist of about 86 per cent $4CaO \cdot P_2O_5$ with 10 to 11 per cent of silicates of metallic oxides.

Nos. 5 and 6. Two varieties of flat black needles, the one magnetic, the other not. No. 5 contained about 10 per cent $CaO \cdot Al_2O_3$, 45 per cent $3CaO \cdot Fe_3O_4$, and 33·5 per cent $3CaO \cdot Fe_2O_3$. No. 6 contained about 15 per cent $CaO.Al_2O_3$ and 73 per cent $3CaO \cdot Fe_2O_3$.

Discussion.

In reply to a question by Mr. Thompson, Mr. Ridsdale stated that Mr. Meiers had determined the crystalline forms of the substances which had been described, and had examined them in polarised light. In reply to Mr. Nettlefold, he said that they were of opinion that the whole of the phosphorus was present as $4CaO \cdot P_2O_5$.

43. "*Note on the Influence of Temperature on the Heat of Dissolution of Salts in Water.*" By William A. Tilden, D.Sc., F.R.S.

In a paper which appears under this title in the April number of the *Transactions*, Mr. Pickering reviews the experiments which he had previously published upon the same subject, and so far modifies the conclusions which he had drawn from those experiments as to admit that the lines representing the heat of dissolution of various salts at successive temperatures do not consist of a series of curves following one another at irregular intervals. But Mr. Pickering maintains that the new experiments now published lead to a result which only differs in degree from his former conclusion, and involves admissions which are essentially of the same character as those which he has abandoned. His main conclusion will be best expressed in his own words (p. 335):—"The heat of dissolution of a salt increases uniformly with the temperature up to a certain point, when the rate of increase is suddenly lowered, and this fresh rate continues uniform till lowered again at some higher temperature," &c.

The consequence of this is that the graphic representation of the results must, according to the author, consist of two or more straight lines, which in the cases which he has examined, and within the limits of temperature to which his experiments have been confined, meet at 8° to 10°, or in some cases at higher temperatures. And although the suggestion was made by Dr. Alder Wright, at the discussion which followed the reading of the paper, that the results might be represented by continuous curves without these breaks, the author deliberately rejects this suggestion, and adds a postscript to his paper emphasizing his own view.

The experimental work upon which this conclusion is based is, if not quite unimpeachable, at any rate of a high order of excellence, surpassing any other published work on the same subject within my knowledge. It is only in the interpretation of the results that I venture to differ from Mr. Pickering, but I think it is so plain that his main proposition is untenable, that I feel it desirable to direct attention to the question whilst the work is fresh in the recollection of the Society.

Without any desire to be hypercritical, I think some exception might be taken to the way in which the means appear to have been arrived at. Instead of taking the arithmetical means of the values resulting from experiments performed at the several temperatures, the mean results have been deduced from the lines representing the various series, whether experiments were done at all the points or not (p. 304). The effect of this is naturally to straighten on the line between temperatures where experiments were not made.

I may also remark that in the statement of the differences (postscript, p. 336) between the values calculated from the equation for the curve and the author's values, the word "observed" values must be understood as these "mean" observed values which are not the exact mean values for each temperature. But after all this way of calculating affects the values of the mean to a very small extent, and has not destroyed their significance. Taking Mr. Pickering's own figures as representing the mean experimental results at the successive temperatures, and simply plotting them out on squared paper, I submit that inspection is sufficient to show that every one of his series conforms to a continuous curve, which, considering the difficulties of the work, is generally quite remarkably smooth and free from irregularities.

With reference to potassium chloride, the author remarks (p. 304) that "the sixteen mean results from 10—25° inclusive evidently form a straight line," and that the experiments below 9° form another straight line. To this I demur. I do not see how such an idea could have arisen, unless it was from the differences tabulated on p. 306, from which it appears that the increase in the value of M per degree drops from 50 cals. between 8° and 9° to 42 cals. between 9° and 10°. Looking at other parts of the table, however, it will be noticed that even greater irregularities occur, as for instance—

at 16—17° the difference is 33 cals.
17—18 ,, 45 ,,
18—19 ,, 36 ,,

If a fall of 8 cals. at 8° to 9° is held to justify the assumption of a break in the line at this point, why should not another break be accepted when there is a rise of 12 cals. or a fall of 9 cals. in the rate at the temperatures referred to?

Similar remarks apply in other cases. Potassium nitrate, for example, shows a change in the rate of increase

from 40 cals. at 12—13°
to 23 ,, 13—14.

It is not clear why the break should be introduced here, when at only one degree higher there is a change of greater amount, viz.—

from 23 cals. at 13—14°
to 42 ,, 14—15,

and yet no corresponding change is recognised in the curve.

In discussing these curves I have added the graphic representation of all the experiments, in order that they may be compared with the means, and that no injustice may be done to the author's view.

Again, in the case of sodium chloride the mean differences given in the Table (p. 308) seem to indicate, if any, four rather than two straight lines, the value being—

3— 7°	44·5 cals.
7—11	38·0 ,,
11—18	31·7 ,,
18—25	29·5 ,,

Though the curves are somewhat irregular in some of the other cases, especially that of sodium carbonate, the hypothesis of sudden breaks is not supported sufficiently to make it acceptable in the face of all the probabilities pointing the other way. Such irregularities might

naturally be expected in work of this nature, surrounded with difficulties as it is.

Mr. Pickering criticises severely the results I obtained in the attempt to get determinations of the heat of dissolution over a considerable range of temperature. I am indebted to Mr. Pickering for reminding me of the necessary validity of the formula of Person, which shows the dependence of thermochemical effects upon temperature. The discrepancy between the calculated values in that paper and the experimental results arose from the mistake of assuming the values for the specific heats of the several solutions to be practically constant throughout, whereas they increase with rise of temperature, though to an extent which, according to the experiments of Marignac, is very small, from about 20° C. to 50°. But this does not destroy the experimental numbers which, though subject to a general error which makes them all somewhat too low, are consistent among themselves, and support the conclusion that the rate at which the heat of dissolution is influenced by temperature diminishes as the temperature rises. Fortunately this accords with the results of Mr. Pickering's own work, whether we do or do not adopt the hypothesis which he prefers, that the changes occur suddenly. In my opinion all the probabilites, in addition to Mr. Pickering's own results, indicate that the heat of dissolution of a salt in water is a continuous function of the temperature.

Discussion.

Mr. Pickering, in reply, said that, after a very careful re-examination of his results, he found it impossible to accept Prof. Tilden's interpretation of them. In the first place he defended the method which he had employed in deducing mean values: this consisted in separately plotting each series of experiments by drawing lines to connect the various values of each series, and deducing the final mean by taking the mean of the values given by these lines at each degree; and it was to be noted that the means were not deduced from the lines representing the individual series after the irregularities in them had been smoothed out, as in the dotted lines in Plate I., as Prof. Tilden appeared to think they were,—probably through a want of clearness in the explanation given at p. 304 of the speaker's paper. The method described would give unfair results in the event of one series containing a far larger number of determinations than another, and to avoid this he had never applied the method when a greater interval than 2° separated the successive experiments in any series. Though not perfect, this method is certainly the fairest which can be adopted, and beyond comparison much fairer than that suggested by Prof. Tilden. Two series, consisting of experiments performed at alternate degrees and free from any experimental error, except that made in standardising the thermometers (which would cause the results of one series to be uniformly above, and those of the other uniformly below the truth), would each yield a straight line, if such were the nature of the true results, whereas their mean deduced by Prof. Tilden's method would be a wavy line, and was obviously incorrect.

Mr. Pickering said that the concordance between his results and the curve or straight line method of representing them was so close that it was quite impossible by mere inspection of a diagram to decide which method was the best. The whole question depended on the magnitude of the average error in the two cases, and Prof. Tilden had brought forward no numbers to show that a curve indicated a smaller error than straight lines. On the other hand, Mr. Pickering had examined the average error in the two cases very carefully. In the additional note to his paper he had shown that a curve (deduced from the actual results just as the straight lines were deduced from the actual results) did not agree with the mean results so well as his straight lines: in the six cases which he examined the curve would represent a very considerable increase in the average error, and at the same time the sign of the error in the individual experiments was not positive and negative promiscuously as in the straight line diagram, but errors of like sign were grouped together, the numbers deduced from the curve being above the actual results throughout a considerable range, and then below them throughout another considerable range.

Mr. Pickering had examined in the same way the results of each individual series performed with potassium chloride; the average errors, according to the two methods of representing the results, were—

	Straight line.	Curve.
'08 A	4·7 cals.	5·3 cals.
'61 A	4·0 ,,	5·7 ,,
'08 B	1·3 ,,	4·7 ,,
'61 B	4·6 ,,	—

Thus in every case the curve did not represent the results so closely as the straight line. With series '61 B the "curve" equation obtained represented a practically straight line.

Another way in which he had attempted to investigate the question was to find the equation which represented those portions of the diagram which he considered straight (from 9° to 25° with potassium chloride), and to see whether they gave a curve which could by any means represent the other results (below 9°). The various values of β in the equation to the curve $(1+\alpha t+\beta t^2)$ which he obtained were—

Mean of 9 equations from series			'08 A	+0·094
,, 8 ,,		,,	'61 A	−0·056
,, 2 ,,		,,	'08 A	+0·094
,, 2 ,,		,,	'61 A	+0·674
Mean (weighted according to number of experiments included)				+0·025

which value represents a line so nearly straight that it would deviate from straightness by only 4 cals. from 9° to 25°, or 6 cals. from 3° to 25°, whereas the actual results show a deviation of 152 cals. between these last-mentioned limits. The results from 9° to 25° are, therefore, not conformable with those from 9° to 3°. Thus in every way in which the results are examined they undoubtedly favour the straight line as opposed to the curve method of representation.

In answer to Prof. Tilden's question referring to the results given in Table I., Mr. Pickering said that he thought it obvious why he should have taken the increase of 42 to 50 cals. (9° to 8°) as significant of a true alteration in the rate, and should not have taken the diminution of 45 to 33 cals. (18° to 17°) as having any significance at all: in the latter case the difference of 45 cals. is evidently an exceptionally high result, unsupported by any other observation, which when combined with the differences immediately preceding and following it (36 and 33 cals.) gives the same mean as 16 differences from 25° to 9°, whereas the difference of 50 cals., while higher than any differences preceding it, is identical with the mean of the five differences which succeed it (8° to 3°).

He thought that no theoretical speculation should induce us to reject the more correct method of representing his results in favour of the less correct method. Finally, he pointed out that, although the influence of temperature on any chemical change is represented by a curve, this curve really occupies but a very small proportion of a diagram representing the effect of temperature from the absolute zero to the highest known temperatures, and that this diagram consists of practically straight lines inclined to each other at different angles, and joined by curves, presenting an appearance, when reduced to the same scale, precisely analogous to that which he considered his dissolution results presented.

44. "*The Distribution of Lead in the Brains of Two Factory Operatives Dying Suddenly.* By A. Wynter Blyth.

At a certain lead factory in the East of London five cases of more or less sudden death at different dates have been attributed to the effects of lead. In two of the cases the author had an opportunity of making a toxicological investigation. In the one case 24·25 m.grms. of lead sulphate was separated from the liver and 5·4 m.grms. from one kidney; there was also lead in the brain.

In the second case investigated, occurring about a year after the first, the brain was more exhaustively examined, the cerebrum and cerebellum being treated separately and divided up by suitable means into white matter, kephalin, ether extract, substances soluble in cold alcohol and albumenoid residue, and the lead determined in each.

	Cerebrum, 460·8 grms.	Cerebellum, 156·2 grms.
Aqueous extract	1·1 m.grms.	0·4 $PbSO_4$
White matter (kephalin-free)	—	5· ,,
Kephalin	1·5 ,,	6·0 ,,
Ether extract (from which kephalin had been precipitated)	—	—
Substances soluble in cold alcohol	—	—
Albumenoid residue	40·0 ,,	6·0 ,,
	42·6	17·4

Calculated on the whole cerebrum this would amount to 99·7 m.grms., or a possible total for the whole brain of 117·1 m.grms. $PbSO_4$.

There has hitherto been no reasonable hypothesis to explain the profound nervous effects of the assimilation of minute quantities of lead; but if it is allowed that lead forms definite compounds with essential portions of the nervous system, it may then be assumed that in effect it withdraws such portions from the body; in other words, the symptoms are produced not by poisoning in the ordinary sense of the term, but rather by destruction,—a destruction it may be of important nerve-centres.

45. "*Researches on Silicon Compounds and their Derivatives.* II. *A New Chlorobromide of Silicon.*" By J. EMERSON REYNOLDS, M.D., F.R.S.

In purifying a large quantity of silicon tetrabromide prepared by means of crude bromine, the author has separated a portion boiling at 140° to 141°, of the relative density 2·432, which analysis shows to be the chlorobromide of the formula $SiBr_3Cl$.

At the next meeting, on May 19th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Formation of Hyponitrates." By Prof. Dunstan and T. S. Dymond.

"Ozone from Pure Oxygen; its Production and its Action on Mercury, with a Note on the Silent Discharge of Electricity." By W. A. Shenstone and J. T. Cundall.

"The Thermal Results of Neutralisation and their Bearing on the Nature of Solution and the Theory of Residual Valency." By S. U. Pickering.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, May 2, 1887.

Sir WILLIAM BOWMAN, Bart., LL.D., F.R.S., Manager and Vice-President, in the Chair.

THE Annual report of the Committee of Visitors for the year 1886, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The real and funded property now amounts to above £83,000, entirely derived from the contributions and donations of the members.

Forty-eight new Members paid their admission fees in 1886.

Sixty-three lectures and nineteen evening discourses were delivered in 1886.

The Books and Pamphlets presented in 1886 amounted to about 288 volumes, making, with 443 volumes (including periodicals bound) purchased by the Managers, a total of 731 volumes added to the Library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as officers for the ensuing year:—

President—The Duke of Northumberland, K.G., D.C.L., LL.D.

Treasurer—Henry Pollock.

Secretary—Sir Frederick Bramwell, D.C.L., F.R.S., M. Inst. C.E.

Managers—Joseph Brown, Q.C.; Sir James Crichton Browne, M.D., LL.D., F.R.S.; The Earl of Crawford and Balcarres, F.R.S., F.R.A.S.; Frank Crisp, LL.B., B.A., F.L.S.; Warren de la Rue, M.A., D.C.L., F.R.S.; Henry Doulton; John Hall Gladstone, Ph.D, F.R.S.; Sir William Withey Gull, Bart., M.D., D.C.L., F.R.S.; William Huggins, D.C.L., LL.D., F.R.S.; Alfred Bray Kempe, M.A., F.R.S.; George Matthey, F.R.S., Assoc. Inst. C.E.; The Right Hon. Earl Percy; Sir Frederick Pollock, Bart., M.A.; William Henry Preece, F.R.S., M. Inst. C.E.; Edward Woods, Pres. Inst. C.E.

Visitors—Forster F. Arbuthnot; Shelford Bidwell, M.A., F.R.S.; John Birkett, F.L.S., F.R.C.S.; Michael Carteighe, F.C.S.; The Very Rev. Dean Church, M.A.; Edwin Cutler; James Farmer; Charles Hawksley, M. Inst. C.E.; David Edward Hughes, F.R.S.; John W. Miers; Frederick Purdy, F.S.S.; Lachlan Mackintosh Rate, M.A.; William Chandler Roberts-Austen, F.R.S.; George John Romanes, M.A., LL.D., F.R.S.; James Wimshurt.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

SIR,—The secrecy with which the Institute carries on its existence is, I imagine, unparalleled, except among avowedly secret societies. Writing to the secretary some months ago for particulars as to terms of admission, I was vouchsafed no reply. I have, however, been informed by one F.I.C. of the following particulars:—

1. That the annual subscription has been reduced to half-price, *i.e.*, to one guinea.
2. That candidates are now admitted *without examination.*
3. That the Council propose to obtain, if they can, an Act of Parliament excluding from the profession all who are not Fellows of the Institute.

Possibly, the publication of this may induce the chemical sphinx to reveal.—I am, &c.,

F.C.S.

May 7, 1887.

Influence of Pressure in the Modification of Dissolved Chlorides.—G. Foussereau.—The electric resistance of a solution of ferric chloride containing 1·33,260th of that salt diminished from 114,310 to 113,160 after ninety minutes of a pressure of 175 atmospheres. The resistance has, therefore, declined by about one-hundredth of its value, showing that the modification of the chloride by water has increased under the influence of pressure, since this alteration is accompanied by an abatement of resistance.—*Comptes Rendus*, civ., No. 17.

NOTICES OF BOOKS.

Report on the Waters of the Hudson River, together with an Analysis of the same. By C. F. Chandler, Ph.D. New York: Trow's Printing and Bookbinding Co. 1885.

The examination of the water of the Hudson River was made with special reference to its present condition, and to whether it is still safe to rely upon it as a source of supply for the city of Albany. The water was examined for a similar reason in 1872, and was found to be of satisfactory quality; but as many changes have occurred since that time it was thought advisable to have fresh tests made, especially with regard to sewage contamination. This was effected by distilling the water with permanganate of potash, and carefully estimating the ammonia formed. The samples were taken from the river at the inlet to the pumping-station. The results are given in tabular form. Table II. gives them in grains per United States gallon of 231 cubic inches, and Table III. shows them as parts per 100,000. For the purpose of comparison tables of analysis of other American and foreign waters are also given.

Careful examination of these results shows that the water at Albany contains a smaller quantity of albumenoids than the water above Troy (which is higher up the river), in spite of the fact that there is undoubtedly some contamination in its passage past Troy. This is entirely in keeping with the theory of spontaneous purification about which so much has been written and said by Drs. Tidy, Frankland, Warington, and others; but there are still some chemists who do not believe in this theory. Mr. Chandler inserts a few quotations from well-known writers on the subject.

A further comparison of the Hudson River water at Albany with the chief waters used in America and England shows that the Hudson water does not contain any excessive quantity of organic matter.

Great stress is now laid by many persons on what is called the biological analysis of water,—that is, the study of the minute organisms which for more than two hundred years have been known to exist in water. Fermentation, which was first supposed to be a purely chemical action, is now ascertained to be entirely due to the agency of these organisms. This and other discoveries gave rise to what is known as the "germ theory" of disease—that many diseases were due to the presence of peculiar micro-organisms.

As an example of the popular idea of germs we may mention a case which has recently occurred within our knowledge: a well-known chemist received a sample of water, and a note requesting him to examine it for scarlet fever, and state how much there was in it. If these bacteria, &c., were only present in bad or polluted water, there would be some grounds for such an assumption, but as a matter of fact they are omnipresent; it is almost impossible to get a drop of water which does not contain them. Under these circumstances, says Dr. Chandler, it would appear that counting the number of bacteria that will develop in gelatin on the addition of a sample of water is not a very reliable method for determining the quality of water for domestic purposes.

After examining the water of the Hudson River by every possible method, Mr. Chandler finds no evidence which could lead him to change the opinion expressed in 1872, and there is no reason why the city of Albany should not continue to use this water.

Sale of Food and Drugs Act.— Mr. Bernard Dyer, B.Sc., F.C.S., has been appointed Public Analyst for the City of Truro.

Artificial Production of Magnetite.—Alex. Gorgen.—The author has reproduced this mineral by a novel process, consisting essentially in the action of iron sulphide upon an alkaline sulphate.—*Comptes Rendus*, civ., No. 17.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 17, April 25, 1887.

Rapid Determination of Active Limestone in Soils.—Paul de Mondésir.—When a vessel is partly filled with water saturated with carbonic acid, this gas diffuses itself slowly in the air, which fills up the remaining space in the flask. After agitation for about a minute an equilibrium of distribution of the carbonic acid between the air and the water is reached provided that the water occupies only a small portion of the flask. Upon this fact the author founds an apparatus and a process for the rapid approximate determination of the available calcareous matter in soils. The apparatus cannot be intelligibly described without the accompanying figure.

Method of Detecting Correlations between Two Orders of Facts.—M. de Montessus.—The author calls attention to the dangers of this method. It consists essentially in taking two chronological series of natural facts, between which a relation has been supposed, *à priori*, and in searching for their coincidences. But as far as it is known to him the following problem has not been analytically solved, there being given two series of points arranged upon two right lines according to laws which are known in the one case and which are to be found in the other, what will be for a hundred points the minimum number of coincidences allowing us to believe in a correlation of cause and effect between the two orders of phenomena?

On the Alkaline Vanadates.— A. Ditte.—The author has examined and described six lithium vanadates. The anhydrous salts of all the alkaline metals are reducible to a small number of simple formulæ; the hydrates contain proportions of water which vary with the circumstances of crystallisation, but their general properties are the same. The acid salts are of a red colour, more or less inclining to orange; the neutral salts are colourless, and the basic salts are some of them coloured and some colourless.

The Hydrates of Sodium Arseniate.—H. Lescœur.—The author finds the water in the crystalline sodium arseniates differs in quantity from 43 to 57 per cent.

Qualitative Detection of the Suphites in presence of Hyposulphites and Sulphates.—A. Villiers.—This paper will be inserted in full.

On the Sulphurous and Degenerated Sulphurous Waters of Olette.—Ed. Willm.—This paper, though placed under the head "Analytical Chemistry," does not contain any novel or improved analytical method.

On Synthetic Aceto-nitrile.— Louis Henry.—The acetonitrile obtained by the author's process is perfectly identical with that obtained by the dehydration of acetamide.

The Presence of Normal Butylic Alcohol in a Brandy from Cognac; Comparison of the Higher Alcohols of this Brandy with those Produced in the Fermentation of Sugar by Elliptical Yeast.—E. Claudon and E. C. Morin.—In this brandy normal butylic alcohol and butyric acid are present. The brandy in question was not saleable on account of its strong savour of butyric acid, which was present to the extent of 117·4 grms. per hectolitre of absolute alcohol. The brandy contained 48·1 propylic alcohol, 18·5 isobutylic alcohol, and 139·5 grms. amylic alcohol as against 3·1, 2·4, and 80 grms. of these products found in the alcohol obtained from the fermentation of sugar by the elliptic yeast.

On Bichlorated Ethylic Alcohol.—Maurice de Lacre.—This compound is a colourless liquid, thick and viscid, of a characteristic odour and of an aromatic and pungent flavour. It does not solidify in a freezing-mixture of sodium sulphate and hydrochloric acid. Its specific gravity at 15° is 1·145. It boils without decomposition at 146°. Its vapour density is 3·93 experimentally, or 3·97 theoretically. It is sparingly soluble in water, but dissolves readily in alcohol and ether. It reduces ammoniacal silver nitrate, and does not dissolve calcium chloride.

Journal de Pharmacie et de Chimie.
Series v., Vol. xv., No 5, March 1, 1887.

Metals and Minerals from Ancient Chaldea. Sources of Tin in Antiquity.—M. Berthelot.—Already noticed from the *Comptes Rendus*.

Disinfection Stoves.—From the experiments here described it is concluded that the moist steam stove at high pressure, as proposed by MM. Geneste and Herscher, is an excellent instrument for disinfection. At the temperature of 106° all the pathogenic microbia tried were found to have been killed, even in a mattress. Dry air and steam without pressure were found much less efficacious.

Behaviour of Different Bacteria in Potable Water.—Meade Bolton.—Water not containing sufficient organic matter to be detected by our analytical methods is capable of nourishing the lower micro-organisms, and of permitting their multiplication.

No. 6, March 15, 1887.

Certain Coloured Reactions of the Arsenic, Vanadic, Molybdic, and Arsenious Acids.—M. Lévy.—Already noticed.

New Ureometer.—Dr. Georges Frütiger.—This illustrated paper is from the *Bulletin de la Soc. Chimique*.

Action of Mercurial Vapours upon Leaves.—Victor Jodin.—The author has observed that the activity of the respiratory function becomes greater when the leaf is exposed to the influence of mercury. A second fact, quite unforeseen, is that leaves exposed to mercury lose their power of resistance to desiccation. A litre of air saturated with mercurial vapour at 20° contains at most 0·00071 grm. of mercury, and yet this quantity is sufficient to mercurialise 30 grms. of fresh leaves.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série, Vol. ii., March, 1887.

New Production of the Alkaline Metals.—H. X. Castner.—This process consists in reducing the alkaline hydroxide or carbonate, when melted, at a moderate temperature, by causing a metallic carbide or its equivalent to react upon it, thus dispensing with the large quantity of carbon, and with the lime now employed. The reducing agent employed remains below the surface of the alkaline bath, and is consequently kept in constant and direct contact with the melted alkali. It is formed by coking an intimate mixture of tar and iron, the latter in a fine state of division, as obtained by the action of hydrogen. For each kilo. of pure caustic soda there are required 22 kilos. of this iron carbide. The operation is effected in large cast-iron crucibles. The yield may reach 90 per cent.

Archives Neerlanaaises des Sciences Exactes et Naturelles.
Vol. xxi., Part 4.

This issue contains no chemical matter.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 3, February 5, 1887.

Artificial Production of Zincite and Willemite.—Alex. Gorgen.—The author has obtained zincite, crystalline zinc oxide (which had previously been formed artificially by several chemists), from zinc sulphate, nitrate, and fluoride. Willemite, a natural neutral zinc silicate, has also been previously obtained artificially. The author forms it by the action of silica upon several salts of zinc.

Relations of the Efflorescence and the Deliquescence of Salts with the Maximum Tension of Saturated Solutions.—H. Lescœur.—The author gives two tables, the one containing the maximum tension at +20° of certain saturated solutions, represents the scale of deliquescence at this temperature. The second, which gives the dissociation-tensions of various hydrates at +20°, representing the scale of efflorescence at this temperature.

Maximum Tensions of the Vapour of Sodium Acetate.—H. Lescœur.—The author prepares three systems of solutions of this salt and determines their vapour tensions, which are given in the form of tables.

Neutralisation-Heats of the Malic and Citric Acids and their Pyro-derivatives.—H. Gal and E. Werner.—It appears that the total neutralisation-heat of the pyro-acids (excepting the itaconic) is higher than that of the generating acids by about two calories. This is a relation analogous to that already observed between the monobasic acids and the corresponding alcohol-acids.

Neutralisation-Heat of Meconic and Mellic Acids.—H. Gal and E. Werner.—The numbers yielded by meconic acid are lower than the corresponding ones of mellic acid. The heat liberated in neutralisation diminishes in proportion as this advances. In the first place are observed values corresponding to the most energetic acids, then to the alcohol acids, and lastly to the weak acids. The figures obtained for mellic acid enable us to foresee some well-known facts. Neutral sodium mellate, if evaporated with an excess of hydrochloric acid, loses a part of its base, and gives an acid salt. This same salt is produced on heating an alkaline chloride with mellic acid. These numbers lead us to think of the polybasic mineral acids in which the different hydroxyls are fixed on the same radicle, and which yield similar thermic results, such as the sulphuric, chromic, and phosphoric acids.

Neutralisation-Heat of the Glyceric and Camphoric Acids.—H. Gal and E. Werner.—These figures confirm entirely the remarks made in a former communication.

Caprylic Aldoxime and Methl-hexylic Acetoxime.—A. Béhal.—These two bodies have a similar appearance, but differ in their boiling-points; aldoxime boils at 121° to 123°, and acetoxime at 116° to 117°. Both are oily liquids, which stain paper. Their odour is aromatic, mixed with something fetid, and is very tenacious. They do not solidify if exposed for an hour to a mixture of ice and salt. They are lighter than water, and dissolve readily in alcohol and ether.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Watermark in Paper.—We shall be glad to supply information respecting imitation watermarks on application.—Cross and Bevan, 4, New Court, Lincoln's Inn, W.C.

Action of Mercury on Steel.—Could any of your readers kindly inform us what action quicksilver has on steel by constant immersion; whether it coats it or perforates it in time? If so, could they tell us what metal quicksilver has no effect upon?—F. & S. Dixon.

[Mercury has no solvent action on steel or iron; it merely wets the surface and adheres to it, in the same way that water wets glass.—Ed. C.N.]

MEETINGS FOR THE WEEK.

Monday, 16th.—Society of Arts, 8. (Cantor Lectures). "The Chemistry of Substances taking part in Putrefaction and Antisepsis," by J. M. Thomson, F.C.S.
—— Society of Chemical Industry, 8. "Note on the Action of Zinc Chloride on Castor Oil." by Dr. C. R. A. Wright, F.R.S. "New Method of Estimating Moisture in Superphosphates and Similar Fertilisers," by John Ruffle, F.C.S. "Further Notes on English-grown Tobacco," by A. Wingham, F.C.S.
Tuesday, 17th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "The Modern Physiology of the Brain, and its Relation to the Mind," by Prof. Victor Horsley, F.R.S.
—— Society of Arts, 8. "The West Indies at the Colonial and Indian Exhibition," by Sir Augustus Adderley.
Wednesday, 18th.—Society of Arts, 8. "Progress in Telegraphy," by W. H. Preece.
—— Meteorological, 7.
—— Pharmaceutical, 11. (Anniversary).
Thursday, 19th.—Royal Institution, 3. "The Chemistry of the Organic World," by Prof Dewar, F.R.S.
—— Chemical, 8. "The Formation of Hyponitrites," by Wyndham R. Dunstan and T. S. Dymond. "Ozone from Pure Oxygen," by W. A. Shenstone and J. T. Cundall. "On Thermal Results of Neutralisation and their bearing on the Nature of Solution, and the Theory of Residual Valency," by S. U. Pickering. "Action of Metallic Alkalates on Mixtures of Ethereal Salts and Alcohols," by Prof. Purdie.
Friday, 20th.—Royal Institution, 9. "Bridging the Firth of Forth," by Benjamin Baker, M.Inst.C.E.
Saturday, 21st.—Royal Institution, 3. "Victorian Literature," by Prof. John W. Hales, M.A.

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THE CHEMICAL NEWS.

Vol. LV. No. 1434

NOTE ON THE SPECTRUM OF DIDYMIUM.

By CLAUDE M. THOMPSON, M.A., D.Sc.

It is well known that the absorption spectrum usually ascribed to didymium shows six bands in the blue and violet with approximate wave-lengths, 482, 476, 469, 462, 444, 428, according to Lecoq de Boisbaudran.

The evidence that we at present possess shows, I think, that these bands belong to at least five different fractions of didymium.

Welsbach (*Monatshefte*, vi., 477) has shown that the band 428 occurs in the absence of all the others mentioned above in the spectrum of the fraction which he names neodymium. On the other hand Crookes (*Proc. Roy. Soc.*, 1886, 502, Fig. 1) has shown that all the other bands of neodymium can be obtained in the absence of the band 428. This band, therefore, belongs to a distinct fraction, and should be obtainable quite by itself.

Crookes has shown that the band 444 varies in strength independently of all others, and is therefore distinct. The same conclusion is arrived at by a slightly different argument. Welsbach's praseodymium shows the bands 482, 469, and 444, together with a faint band in the orange. Crookes (*Ibid.*, Fig. 1) has shown that 482 and 469 can be got in a fraction which does not show 444. It is possible that the faint orange band of praseodymium belongs to the same fraction as 444, since its presence or absence would make little difference in the appearance of the dark orange band of the ordinary didymium spectrum, one part of which it forms.

The band 462 is shown to be distinct by a comparison of Crookes's Figs. 1 and 2, taking into account that 444 and 428 have been shown to be distinct.

The two bands 482 and 469 seem always to accompany each other. They occur together in Welsbach's praseodymium and in all the spectra of didymium fractions published by Crookes. They are distinct from 476, since they occur in praseodymium in the total absence of 476. They may belong to the same fraction as the faint orange band of praseodymium.

The band 476 does not occur in Welsbach's neodymium spectrum.

In fact the two bands 476 and 462 seen in the didymium spectrum are not accounted for by Welsbach at all in the spectra of praseo- and neodymium. Since 462 is distinct, 476 must also be distinct.

I have repeated Welsbach's experiments up to a certain point, and can confirm his results as regards praseodymium in every respect. There is no indication whatever that the three main bands belong to different fractions. I have not been able to satisfy myself quite that the faint orange band of praseodymium really belongs to the same fraction as the others, even supposing that the method of fractionation is not changed. In the didymium spectrum the orange band is much darker than the green, and the difficulty of getting a really concentrated praseodymium solution, which does not show a trace of the green band, is extreme. A small remnant of some other fraction of didymium might therefore cause a faint band in the orange some time after the band in the green had disappeared. Nevertheless, there is no doubt that, by Welsbach's method the orange didymium band is split up, for the maximum absorption with didymium is not at the point in the orange where the band of praseodymium occurs.

I have not yet obtained the neodymium fraction free from praseodymium, but I have no reason to doubt that Welsbach's observations are correct. A study of the intermediate fractions brings out a point which Welsbach does not refer to. As we pass from the praseodymium end the bands 482 and 469 become fainter, whilst 476 and 462 first appear and then grow stronger, till they become distinctly stronger and much broader than 482 and 469.

It appears then that the absorption spectrum of didymium is splitting up just as the fluorescent spectrum of yttrium is. I have only discussed a few of the bands, but there is no doubt that the other bands will also in time be separated. Indeed, this separation has already been partially effected by Crookes for some of the bands in the red.

Perhaps the most surprising result arrived at by Crookes is that the splitting up of the fluorescent yttrium spectrum is unaccompanied by any change in the spark spectrum. On the other hand Welsbach states that the spark spectra of praseo- and neodymium are parts of the didymium spectrum, and that though similar in general appearance, they are really quite distinct. There does not appear to be any theoretical reason for this difference between yttrium and didymium, and it is to be hoped that the different fractions of didymium will be got pure enough to show whether the spark spectra can be still further split up.

University College, Cardiff.

ON A FUNDAMENTAL LAW OF THERMO-CHEMISTRY.

By SPENCER U. PICKERING.

My attention has been called to a paper which appeared in the Chemical News, vol. lv., p. 144, under the above title, in which the author arrives at the conclusion that each atom has a constant "thermal equivalent" or heat of combination, when the different atoms are compared under similar conditions. These "equivalents" he calculates for the various atoms, and then proceeds to show that the heat of formation of compounds as calculated from the constants agrees very closely with the observed values. The way in which the constants are calculated is as follows:—

"[H,Cl]Aq = 39·315 [H,Cl,Am]Aq = 53·691
[4Am,3Cl] = 124·661 .

Now assuming the truth of the law that the radicals liberate or absorb the same amount of heat in all cases, we may write H + Cl = 39·315, H + Cl + Am = 53·691, 3Cl + 4Am = 124·661, whence we get H = 16·963, and Cl = 22·352.

Again, knowing Aq[H,Br] = 38·370, we may by hypothesis put H + Br = 28·370, whence Br is 11·407.

In a similar way we get I = − 3·793.

Again, from the heats of formation of the chlorides of various metals, we may easily obtain their thermal equivalents. Thus, the heat of formation of calcic chloride being 187·600, we may put Ca + 2Cl = 187·600, whence we find the thermal equivalent of Ca = 142·896. In this way I have calculated the thermal equivalents of Li, Na, K, Ca, Sr, Ba, Mg, Cd, Zn, Al, Ni, Co, and Cu".

Now if the above law is true we ought to be able to calculate the heat of formation of the bromides or iodides of any of these metals by simply adding their thermal equivalents. The following are a few of the experimental and calculated results:—

	Calculated.		Experiment.
K+Br	= 90·225	Aq[K,Br]	= 90·230
Na+Br	= 85·565	Aq[Na,Br]	= 85·580
Ca+2Br	= 165·700	Aq[Ca,Br_2]	= 165·800"

I give the quotation in full, since I am utterly incapable of understanding how the three equations can be combined so as to yield the results indicated, or indeed any results of a simpler nature than the algebraic sum of six or seven unknown quantities; this much, however, I do under-

stand, that whatever values the author had taken for the last two reactions mentioned above, and whatever values he had, consequently, obtained for H and for Cl, he would have arrived at precisely the same results. The whole performance is, in fact, nothing but a conjuring trick with the fact that there is a constant thermal difference (in dilute solutions) between two similar radicles, independent of the nature of the other radicle with which they may be combined; the "calculated" values are merely a reproduction of the experimental values, *plus* a small amount of error accumulated during the arithmetical processes through which they have passed. I should recommend the author to turn to CHEMICAL NEWS, vol. liv., p. 217, where he will find a dictum of Professor Armstrong's which may apply in the present case: "Put not your faith in constants."

VAPOUR DENSITIES.

By THOMAS T. P. BRUCE WARREN.

SOME time ago I wrote an article on this subject, which I intended as a companion paper to an article "On a New Form of Combustion Tube," which appeared in the CHEMICAL NEWS (June 12, 1885).

As some correspondence on this subject appeared in recent issues of this Journal (February 11 and 18), which reminded me of what I had written, I searched for the MS., which unfortunately has been lost.

The apparatus which I have used (Victor Meyer's tube) has a delivery tube with two bulbs, instead of the straight tube as figured in Sir Henry Roscoe's "Chemistry." This form was taken from the apparatus used at South Kensington, and due I believe to Prof. Hodgkinson; however, I can speak very favourably of this modification of the delivery tube.

Mr. Cetti made three of these tubes for me some two or three years ago, with the South Kensington modification, and, although I have had to use these tubes very frequently, I have not yet met with a mishap or obtained a result which I have had to discard or consider doubtful.

I recognise in the letter which appeared in the CHEMICAL NEWS (February 18), signed N. S. S. (Normal School of Science), an appreciation of the apparatus which it fully deserves.

The modification which I have added is a long perforated cork. The perforation is fitted with a long light stopper, made of tubing closed at the ends. The end of the perforation is loosely plugged with asbestos, so that the small tube containing the liquid whose vapour density is required rests on it, and is pushed down when the stopper is inserted. A good sound cork is preferable to an india-rubber stopper.

The object of this arrangement is that the whole apparatus is made perfectly tight, and the insertion of the tube with liquid can be carefully and securely carried out without the slightest fear of disturbance in the condition of the air in the tube, &c.

It is difficult to make and close such a large opening as the withdrawal and replacement of a cork requires, without involving the chance of escape with very volatile liquids or cooling the air to a slight extent, or even driving a little over into the measuring tube, unless the cork is *precisely* pushed into its previous position.

The small tubes are made by taking ordinary glass tubing about ¼ inch outside diameter, rounding one end and closing it, and drawing the other out into a fine capillary bore. A little experience will enable anyone to make these tubes so as to hold the necessary quantity of liquid. These tubes are filled by slight warming and cooling in the liquid; when quite filled and all air removed they are ready for operation. They should be allowed to cool in the liquid, and, when wiped, handled afterwards by metallic forceps.

A little asbestos is placed in the bottom of the Meyer tube to prevent fracture when the small tube is pushed down. The pneumatic trough consists of a tall cylindrical jar, about 6 inches diameter.

The Meyer tube is first closed, and heated in an oil- or water-bath until no air escapes from the delivery tube. The measuring tube is then clamped in position over the delivery tube, and if no bubbles of air are seen the apparatus is ready for use.

When the expelled air has cooled to the temperature of the water, the measuring tube is raised or lowered until the water-level is the same in the tube and trough.

The tube must not be handled, but should be adjusted by the clamp which admits of being raised or lowered on the stand.

The corrections for differences of temperature and barometer readings are made in the usual way.

The tube from the water-bath should reach some distance up outside the Meyer tube; this prevents draughts, and keeps the tube at a constant temperature. An iron tube, about 2½ inches diameter and 24 inches long, closed at one end by welding, forms a convenient vessel for heating the Meyer tube in.

The tube is heated by a large Bunsen burner with a good supply of gas, and whilst the operation is going on every movement which might create a draught must be avoided.

ON CHECKS IN ANALYSIS.

By W. A. DIXON, F.I.C., F.C.S., Sydney Technical College

IN the numbers of the CHEMICAL NEWS lately to hand there are reports of the American Association of Agricultural Chemistry on methods of analyses. Certain methods are made official for the year in America, but it seems to the writer that—however good the methods may be—there is no certainty of an approach to absolute accuracy when the work is done by different hands.

Perhaps the most accurate commercial work required of any chemist is the assay of gold, and this accuracy is obtained by a system of checks, so that, although the actual weighings of different assayers on a particular sample of gold would give different results if reported directly, the results come to be closely accordant when each corrects his weighings by his own check.

The system of checks seems never to have been adopted in general chemical analysis; at least its adoption has not, so far as I know, been made public, although there has been wrangling enough about the value of different processes, any one of which would be good enough with a check. There is no reason why it should not be used in all determinations where extreme accuracy is required, and it is the only method by which such accuracy can be attained, as all such sources of error as solubility of a substance in water, reagents, &c., are thrown on the check. Some men can succeed better with one process, some with another, and if checks were used the results would be comparable one with another.

I may give, as an example of the method in analytical work, a determination of arsenic as ammonio-magnesian arseniate, for which I first used it. This salt is somewhat soluble even in ammoniacal water, and Fresenius gives a correction to be applied to the mother-liquors, which, however, is inapplicable to the washings,—so this source of error remains, whilst the first is variable with the temperature. The mineral was treated with nitric acid and evaporated nearly to dryness, and then treated with a known volume of water having some arsenic acid in solution. To an equal volume of the arsenic acid solution was added approximately as much chloride of iron as there was of iron in the actual determination; then to each solution were added similar quantities of citric acid, ammonia, and magnesia mixture. The solution and precipitate were treated exactly alike as to

standing, washing, and ignition; first alone, afterwards with starch; and, the magnesia being weighed, the difference between the two gave the datum for calculating the arsenic. The only source of error that arises in this process is that—because of the greater surface of the ammonio-magnesian arseniate in the actual determination—more of the precipitate would be taken up by the wash-water than in the check. This was neglected, but could be checked by using double the wash-water in a second determination.

Examples might be multiplied, but it would be useless, as any one can arrange checks for the work to be done.

This is altogether different from doing a blank experiment, as a blank result may only show the uselessness of the method or worker. It agrees rather with what Kohlrausch ("Introduction to Physical Measurements") says about weighing:—"It is, as a rule, better to make a measure depend not on a trial whether two quantities are equal, for equality is only approximately attainable, but as a trial how much they differ."

NOTE ON THE SEPARATION OF ACETIC AND FORMIC ACIDS.

By D. S. MACNAIR,
Lecturer on Chemistry in Allan Glen's Institution, Glasgow.

The method usually recommended for the detection of acetic acid in presence of formic acid, by destroying the latter by digesting the mixture with mercuric oxide, is somewhat tedious and unsatisfactory. The following method gives good results, and may be used both for the detection and for the quantitative estimation of acetic acid in presence of formic acid.

The substance to be tested is distilled with dilute sulphuric acid, and the distillate, containing the free acids, is then boiled for ten minutes in a flask provided with an inverted condenser,* with an equal bulk of chromic acid mixture (made by dissolving 12 grms. of potassium bichromate in 30 c.c. of sulphuric acid diluted with 100 c.c. of water). By this treatment the formic acid is readily and completely oxidised to carbon dioxide and water, while the acetic acid remains unchanged. The liquid is now distilled, and in the distillate acetic acid (if present) is readily detected by neutralising and adding ferric chloride.

In the following experiments weighed quantities of the pure anhydrous acids were taken, the formic acid destroyed as described, and the acetic acid distilled off and determined by titration with standard alkali:—

	Weight of acetic acid taken.	Found.
I.	1·076 grms.	1·056 grms.
II.	1·171 ,,	1·150 ,,

DEPOSITS OF PHOSPHATE IN ITALY.

By KONRAD WALTER, Engineer.

Considering the serious complaints of capitalists and manufacturers in the most industrial countries of Europe, concerning the continually increasing competition in trade, it might be well to direct their attention to Italy. This country is rich in mineral treasures, but the enterprising spirit of the Italians is not as yet sufficiently awake to take new things in their own hands; they prefer to follow the beaten tracks.

There is no doubt that the mining of metallic minerals in Italy has taken a great development in the last thirty years,—mostly with foreign capital and energy,—but this branch of industry suffers also more or less at present, though there are still many fine enterprises concerning mining business which might be pointed out.

The mining of different other minerals—as phosphates, fireclay, &c.—has likewise not as yet found the consideration due to it, and on those enterprises the attention of capitalists is chiefly to be directed.

There is no doubt that Italy always has been, and is still, an eminently agricultural country. However, rents have recently been going down in a most surprising degree, and this for a simple reason,—because there is no proportion between what is taken year by year from the soil and what is replaced by natural stable manure.

Efforts have been made, chiefly in the North of Italy, to meet this increasing retrogression of the productivity of the soil by means of artificial manures. The results have been of course very satisfactory, but they are paralysed by the high price of the artificial manures, which—and this mostly in the South—have to be imported from other countries. Though many manure works have been erected, the misproportion of the price of manures (chiefly of phosphoric acid) for agriculture still exists. This is shown by the great importation that takes place. Up to now *all mineral phosphates* are imported, and the price of sulphuric acid is still much too high.

Some years ago there was discovered in the South of Italy, near Gallipoli, and directly on the sea-shore, a very considerable deposit of natural phosphates, comprising many millions of cubic feet. This deposit is laying with the outcrops quite on the surface, while the lower strata are falling off to the sea. In geological position this layer belongs to the Eocene formation. In this brittle limestone there are imbedded a great quantity of coprolites, together with bones and other remains of antediluvial animals. According to different trials that were made it appears that about 50 per cent of the whole layer consists of phosphates. The latter are easily separated from the chalk, and contain 35 to 38 per cent of phosphate of lime. If burnt in a limekiln, and separated by hand in a very rude manner, they give a phosphate of 50 to 55 per cent. It is to be remarked that those trials were made with some hundred tons, taken *directly from the surface*, which had been exposed from time immemorial to the action of atmosperic influences and infiltration of carbonate of lime. There has never yet been made any trial to bring up, by boring, samples from deeper layers, which would surely be richer. But, considering the excellent position, comparatively cheap coal, and cheap labour, even the above crude process of enriching the poor phosphates would give excellent results. It would be quite wrong to attempt exportation of these phosphates; the most rational way would be to transform them on the spot into superphosphates. Those latter are easily sold in any quantity in the country itself.

As for the manufacture of sulphuric acid (for this transformation) it is to be mentioned that this might also be made on the spot at exceptionally low cost price, considering that it would be gained as a secondary product.

Rich and poor sulphur ores can be had in unlimited quantities. By using the patent furnace of M. Konrad Walter, chemical engineer in Milan, out of the sulphur ore can be got not only the sulphur, as up to now in the "Calcaronis," but also the sulphurous acid gas in a regular concentrated stream. This latter is to be utilised for the manufacture of sulphuric acid.

(Of the sulphur contained in the natural sulphur stone about 62 per cent are obtained in the now commonly used "Calcaronis"; the remainder goes into the air as sulphurous acid gas.)

As the whole enterprise would be on the sea coast, the transport to all parts of Italy would be much facilitated. Along with the superphosphate a good deal of sulphuric acid might be placed in commerce in the South of Italy, where it is used in considerable quantities by oil-refiners,

* Unless the amount of acetic acid is to be determined quantitatively the condenser may be replaced by a straight glass tube of abou 7 m.m. diameter, and not less than 70 c.m. in length, which should be fitted to the flask by a cork.

dyers, petroleum-refiners, &c. Hitherto prices as high as 70 frs. per ton of acid of 1·7 sp. gr. are paid, while the cost price of this acid made in the above-mentioned manner would not exceed 2 frs. all included.

Besides this, the low cost price and favourable position would even permit of a successful exportation to Southern France, Tunis, Levant, Russia, and Roumania, where the use of those articles is every day increasing.

It is a well-known fact that the Italian Government offers all facilities for the development of national industry, and therefore any such enterprise would find the greatest protection.

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NEW SUGAR REACTIONS.

By DAVID LINDO.

The following paragraph appeared in the *Lancet* of January 8th, under the head of "Two New Tests for Sugar":—

"At a recent meeting of the Vienna Chemico-Physical Society, Dr. Hans Molisch, Assistant at the Phyto-Physiological Institute of Vienna University, described two very delicate tests for detecting sugar in liquids. The reactions employed are the following:—A half cubic centimetre of the liquid containing sugar is mixed with two drops of an alcoholic (15 to 20 per cent) solution of α-naphthol; then concentrated sulphuric acid is added in excess. In presence of sugar the liquid, if shaken, assumes immediately a deep violet colour, and by adding water to the liquid a blue-violet precipitate is formed. In the other reaction thymol is employed instead of α-naphthol, and the liquid containing sugar assumes a carmine-red colour. These reactions are more delicate (as was shown by experiments) than our common sugar-tests, and are successful with most kinds of sugar; they can be also used for proving the presence of sugar in the tissues under the microscope. It was shown also that normal urine of man without any preparation gives the reaction, even if diluted with water to the extent of from 100 to 300 times its volume, and therefore the suggestion that normal urine contains sugar seems to be proved. If normal human urine is diluted with water to more than 300 times, it fails to give the reaction, while urine of diabetic persons can be diluted to a higher degree to exhibit the reaction with α-naphthol."

How the tests are to be applied for proving the presence of sugar in the tissues under the microscope is not apparent. It will be observed no reference is made to the fact—perhaps because considered too obvious to need it—that if the liquid under examination contains any substance convertible into sugar by the action of sulphuric acid and heat, the reaction will be obtained as if sugar had originally been present; yet this must surely greatly reduce the value of the reaction as a test for sugar.

I have made some experiments with the thymol test, but not with α-naphthol, for want of the reagent. Fifteen grms. of thymol were dissolved in alcohol, the volume made up to 100 c.c., and 2 drops of this solution used in each experiment. The quantity of liquid taken for testing was always half a c.c., and of strong sulphuric acid 1 c.c. The acid must be quite free from oxides of nitrogen, or a mistake may easily be made, as will be explained further on.

Dilute starch paste (1 per cent starch) gave a very fine reaction with the test, and a 1 per cent solution of gum arabic (fresh) a very good one. The colour was intense red with the gum at first, but became brownish after a little time from charring. On diluting with 10 c.c. water, and stirring, a fine purple-red precipitate formed in the starch tube, and a dark purple one in the gum. This precipitate is by far the most characteristic feature of the reaction, and will be more fully referred to presently.

One part of cane-sugar in 200,000 parts of distilled water gave a distinct reaction, but none could be obtained with 1 part of sugar in 500,000 parts of water.

All these experiments have been several times repeated; the results were found to be somewhat irregular. Thus with a dilution of 200,000 a tint was sometimes obtained that could not be distinguished from the colour produced with a dilution of 100,000. This is owing chiefly to variations in the rise of temperature that occurs on adding the acid, and cannot be guarded against whatever precautions may be taken.

All samples of normal human urine examined gave the reaction (or one very similar to it) when undiluted, and most of them when diluted with 50 volumes of water. In the undiluted state the reaction was sometimes greatly obscured by charring, but on diluting the product with 20 c.c. of water the purple tinge was always observable, and a purple precipitate fell after some time. When the urines were subjected to the action of sulphuric acid alone, and the products diluted to the same extent as those in which thymol had been used, the difference was very striking, the precipitates being devoid of any purple tinge.

Yet all this, I think it will be pretty generally considered, falls far short of proving the presence of sugar in normal urine,—a complex fluid, which must be acted on by such a potent agent as concentrated sulphuric acid to bring about the reaction.

As our knowledge respecting the nature of these reactions is very imperfect, notwithstanding that attempts have been made by capable observers to explain some of them, it would be unsafe at present to affirm, even, that what occurs with urine on applying the test to it proves that a sugar nucleus at least must be present in the secretion.

I have cautioned against the use of sulphuric acid containing oxides of nitrogen in trying these experiments, the reason being that these bodies, as is very well known, give colour reactions with thymol in the presence of strong sulphuric acid, and some of these reactions cannot be distinguished by the eye from the reaction produced by sugar.

I met with a sample of commercial sulphuric acid containing so much nitrous, that, on adding a little to 2 drops of thymol solution in a test-tube, and shaking, the liquid assumed a bright emerald-green colour; on adding a little water, and shaking, the colour changed to red. If in testing for sugar the reagents had been mixed in this order, the fact that there was something wrong with the acid would have been apparent before adding the liquid under examination; but if half a c.c. of distilled water had been added to the thymol instead of sugar solution, and then the sulphuric acid, a bright red colour would have appeared at once, as if a dilute sugar solution had been used.

If a very dilute solution of nitrite of potassium—say 0·3 grm. in 100 c.c. water—is employed in place of a sugar solution (say ¼ per cent), and used in the same way, the colour reaction obtained with the nitrite will be undistinguishable from that produced by the sugar. On diluting the nitrite product with 10 c.c. water, a purple precipitate may possibly form, though it is not often obtained under the conditions of the experiment. This precipitate is thymol dye, and closely resembles in appearance some of the precipitates obtained in sugar testing. They are easily distinguished by collecting on small filters, and, after washing, adding a small quantity of alcohol. The sugar precipitate dissolves, and the colour is instantly destroyed.* The nitrite precipitate dissolves in the alcohol, forming a beautiful purple solution.

Thymol is not the only stearoptene that yields, with sugar and concentrated sulphuric acid, an intense purple-red product. Kingzett states that common laurel cam-

* At least the purple will no longer be recognisable. This may be due to impurities, which, in testing for sugar as described, it may be safely assumed will always be present in the precipitate.

phor, dissolved in sulphuric acid, gives with sugar a most beautiful colour reaction,—a statement I can fully confirm, though I have not been able to render this camphor available for showing the presence of sugar in highly dilute solutions. Menthol I find gives a splendid reaction, an alcoholic solution being used in the same way as thymol. The solution, however, must be much weaker, 1 grm. of menthol dissolved in 100 c.c. alcohol being strong enough for the purpose.

Half a c.c. of sugar solution, 1 part in 40,000 parts of water, gives a very distinct reaction with this reagent. The menthol used was in crystals resembling in appearance magnesium sulphate.

On adding water, however, to these coloured products from common camphor and menthol, the colours are at once destroyed; there is no characteristic precipitate formed as with thymol, which on this account is decidedly to be preferred as a reagent in testing for sugar.

It is pretty evident these colour reactions are not brought about by the glucose acting as a reducing agent, since with no other substance tried that acts as such have I succeeded in producing them.

The presence of sugar when mixed with glycerin is easily shown by these tests; the glycerin should be mixed with about ten times its volume of water before applying them.

When the reactions have been more closely studied they may find a useful application in revealing the presence of the sugar nucleus in the glucosides. The only one I have tried as yet is salicin, a small quantity of which was boiled in dilute sulphuric acid a few minutes, and the solution tested. Very good reactions were obtained with the thymol and menthol tests.

Kingzett and Hake have shown* that if the purple product formed by mixing ordinary camphor, sulphuric acid, and sugar solution together, is diluted largely with water, the colour is destroyed, but a precipitate forms which if separated and treated with concentrated sulphuric acid developes again the intense purple colour. The following experiment shows the same occurs with menthol:—

Experiment.—Five c.c. cane sugar solution (1 per cent) was placed in a small beaker, 1 c.c. menthol solution (5 grms. in 100 c.c. alcohol) added, then 10 c.c. strong sulphuric acid. The mixture was shaken, and after a few minutes poured into 200 c.c. water. The liquid became turbid, and the colour light yellowish brown. It was filtered at once; the filtrate was clear and almost colourless. The precipitate on the filter, having been first washed with about 100 c.c. water, was treated on the filter with alcohol. The alcoholic solution had a pale yellowish brown colour. It was evaporated at a gentle heat nearly to dryness, and strong sulphuric acid added to the residue: a magnificent purple colour was at once developed.

Altogether the subject is a very interesting one, and chemists should feel grateful to Dr. Molisch for having by his discovery recalled their attention to a class of reactions the correct interpretation of which may lead to results of considerable importance to Science.

Falmouth, Jamaica, B.W.I.,
April 11, 1887.

Final Reaction in Titrating with Fehling's Solution.—E. Beckmann.—The author refers the difficulty of detecting the exact point when the blue colour disappears to an optical deception. A liquid in which a yellow precipitate is suspended is very likely to assume the complementary colour. The best method for avoiding this deception is to titrate until a portion of the liquid, when filtered off, no longer gives the reaction of copper.—*Zeit. Anal. Chem.*

* Kingzett, "Animal Chemistry," page 421. They used a freezing mixture in some of their experiments, and added the sugar solution drop by drop to prevent charring.

THE SAMPLING OF CAST-IRON BORINGS.*

By PORTER W. SHIMER, M. E., Easton, Pa.

As is well known, cast-iron borings are a mixture of small particles of iron with more or less of finely divided graphite, separated from the surfaces of these small particles during the process of boring. The amount of graphite thus mechanically mixed is, in all cases, quite large enough to cause serious difficulty when the problem is to obtain an average sample of a given lot of borings for carbon determination. This difficulty arises from the necessity of obtaining a uniform mixture of the heavy and comparatively coarse borings with the finely divided and light graphite, and of removing a sample for analysis without disturbing the uniformity of this mixture.

It was first sought to overcome this difficulty by having the borings made very fine, so that they might have more nearly the size of the particles of graphite. It was not practicable, however, to secure this uniformity of size, since much of the graphite is in the form of the finest dust. At all events, the duplicate determinations of carbon in these fine borings, made with every precaution by combustion in oxygen, frequently showed differences too large to be accounted for in any other way than by imperfect sampling.

Very coarse borings were also tried with the idea that the graphite separated from these large and heavy pieces would, perhaps, be inappreciable; but it was found that quite enough was separated to vitiate the results.

Various methods of mixing were tried, both in the bottle and on glazed paper; but in all these mixtures it was found that duplicate samples seldom contained the same proportion of the mechanically mixed graphite; and when they did, there could be no certainty that it was the true proportion. All this was shown many times over by the failure of duplicates to agree closely, the difference being sometimes so much as 0·20 per cent. It was finally clear that nothing was to be hoped from these methods. Even if we could secure a perfect mixture containing in every part its due proportion of graphite, it would run a great risk of being destroyed the moment a spatula was inserted to remove a sample: for the least agitation causes some of the graphite to fall through between the coarser borings.

The sampling diffculty was finally overcome in this way: The borings are carefully poured out into a large porcelain crucible or dish, and enough alcohol is added to merely moisten them (2 c.c. alcohol to 30 grms. borings). Mix thoroughly for about five minutes. Remove with a spatula as many samples of the moist borings as are needed, weighing them out roughly so as to get approximately the weights desired. Dry off the alcohol and weigh accurately. The samples thus obtained perfectly represent the average of the original sample, for the alcohol simply serves temporarily to hold the graphite where it belongs, upon the surface of the borings.

As the alcohol evaporates from the original sample the graphite agains falls away from the borings, and the moistening must be repeated when new samples are to be removed.

It is not at all difficult to obtain alcohol sufficiently pure for this purpose. An estimation, based on a determination of the carbonaceous residue left on evaporation, showed that the alcohol used in these experiments would cause an error which would not appear until the fifth decimal place in the percentage of carbon. I have made many duplicate carbon determinations since using the moist sampling method, and have had none but satisfactory results, having never found a greater difference than 0·03 per cent between duplicates. Generally the difference is from 0·01 to 0·02 only.

The following total carbon results show the improvement:—

* *Transaction of the American Institute of Mining Engineers*, Pittsburgh Meeting, February, 1886.

	I.	II.
Mixed dry in the bottle	3·68	3·84 p.c.
Moistened with alcohol and mixed ..	3·97	3·99

The first results are an extreme case of unsatisfactory duplicates; and they also show the tendency of the graphite to go to the bottom of the bottle when mixed dry. The mechanically mixed graphite, approximately determined by removing the iron by means of a magnet from samples taken moist, was 0·76 and 0·79 per cent in duplicate determinations.

After shaking up the dry borings a few times, and removing nearly all from the bottle, the remaining sample contained 1·29 per cent mechanically mixed graphite.

The other determinations, such as phosphorus and silicon (iron excepted), are, perhaps, not appreciably affected when samples are taken dry. But whenever samples are thus taken, the borings which remain are for ever vitiated for carbon determinations which shall truthfully represent the original sample. In very careful work, therefore, and especially when there is any prospect of subsequent carbon determinations to be made, it is necessary to moisten the borings when weighing out samples for phosphorus and silicon, or to have two sets of borings made, one of which is to be reserved for carbon determinations. For iron determinations the samples should always be taken moist.

It was suggested by Mr. Frank Firmstone, Superintendent of the Glendon Iron Works, to determine whether or not there is any appreciable loss of graphitic dust while making cast-iron turnings according to the method devised by him, in which the turnings are taken equally from the whole section of a piece of pig-iron, the outside being first removed. Through the kindness of Mr. Firmstone, I was enabled to procure from the same piece of pig-iron a sample of turnings taken dry, a second sample kept moist with alcohol to prevent loss of dust, and several sections $\frac{1}{2}$ inch in thickness.

The following are the total carbon results from these samples:—

I. Turnings taken dry, but sampled moist.
II. Turnings taken moist.
III. Thin section.

I.	II.	III.
4·132	4·122	4·031
4·123	4·123	4·038
4·111	4·103	4·108

The results under I. and II. show that, with care in catching the turnings, and avoidance of drafts of air, there is no appreciable loss of graphitic dust. The first two results on the thin section are low, because of incomplete decomposition of the iron, when, after forty hours, hydrocloric acid was added to complete the solution. The third result is about right; but complete decomposition was obtained in this case by frequent and long-continued stirring. While, therefore, it is possible to obtain the correct total carbon by use of a thin section, it offers no advantage in point of time; since borings may be dissolved in neutral and cold copper and ammonium chloride solution in fifteen to twenty minutes by constant stirring.

Some chemists, with a keen appreciation of the sampling difficulty, have proposed to overcome it by using clippings of the iron from $\frac{1}{8}$ to $\frac{1}{10}$ inch in thichness. While it is no doubt possible, in most cases, to obtain the true result by this means, it is open to the objection of being very slow when these clippings are to be dissolved in neutral copper and ammoninm chloride solution. Furthermore, the weight of iron taken for carbon determination in cast-iron being limited by convenience to about 3 grms. a very few clippings make up this weight, and these represent only those parts of the sample from which they happen to come. While there may not be an appreciable difference in the composition or in the condition of the carbon of the different parts of a section of pig-iron, it is yet possible that there may be; and in this case it is easy to be on the safe side.

When turnings are taken equally from the whole section of a piece of pig-iron, and are then moistened with alcohol and thoroughly mixed, every part of the section has its due representation in a sample of 3 grms.

It may not be out of place to add, that in sampling ores, and, in fact, any similar mixture of particles of different size, composition, and specific gravity, I am now accustomed to moisten with water before mixing. This secures a uniform mixture of coarse and fine parts from which a true sample can easily be removed, prevents loss of dust, and is in every way more satisfactory than mixing dry.

In pulverised ores it is very commom for the finest part to consist principally of lighter gangue material; and the problem of securing a true sample of such a mixture is similar to that of obtaining a true sample of a mixture of cast-iron borings and graphite.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

May 14th, 1887.

Prof. W. E. Ayrton, Vice-President, in the Chair.

Mr. T. Mather was elected a member of the Society.

The following papers were read:—

"*On a Modification of a Method of Maxwell for Measuring the Coefficient of Self-Induction.*" By E. C. Rimington.

The method referred to is given in Maxwell's "Electricity and Magnetism" (vol. ii., § 778), and is called "Comparison of the Electrostatic Capacity of a Condenser with the Electro-magnetic Capacity of a Coil." The apparatus used consists of a Wheatstone's bridge having the coil in one, and the condenser as a shunt to the opposite, arm. In order that no deflection may be produced, either for steady or unsteady currents, a troublesome double adjustment of the resistances is necessary, and to obviate this the modification was devised. It consists in placing the condenser as a shunt to only part of the arm, and this part can be varied by sliding contacts without altering the whole resistance of the arm. An ordinary resistance balance for steady currents is first obtained, and the sliders are then adjusted until no deflection is produced on breaking the battery circuit. Under these circumstances it is shown that—

$$L = K r^2 \frac{D}{B},$$

where K is the capacity of the condenser, r the resistance between the sliders, and D and B the resistamces of the arms in which the coil and condenser are placed. The conditions of maximum sensibility are investigated, and also those under which a telephone may replace the galvanometer. In the latter it is shown that the only possible solution is when $r = B$, *i.e.*, Maxwell's arrangement. The author believes his modification would be made much more sensitive by adopting the "cumulative" method used by Profs. Ayrton and Perry in their secohmmeter, and in his case neither the speed nor the "lead" need be known.

Mr. W. N. Shaw asked whether any serious difficulties were experienced with telephones, owing to electrostatic capacities of wires, &c.; and Mr. W. E. Sumpner pointed out that the particular arrangement given in Maxwell is not always the most sensitive, as was shown in his remarks at the last meeting of the Society of Telegraph Engineers.

Mr. Bosanquet thought the method a valuable one, and hoped many experiments would be made on coils whose coefficients were calculable, in order to find out the differences between calculated and observed results.

Prof. Ayrton referred to the paper by Prof. J. J. Thompson in the *Philosophical Transactions*, and pointed out that the formula there given for the capacity of a condenser in electro-magnetic measure is identical with that given in Maxwell, § 776, when the printer's error of interchanging a and α, in the denominator for R_2, is corrected.

"*On the Production of Sudden Changes in the Torsion of a Wire by Change of Temperature.*" By R. H. M. Bosanquet, M.A.

A very fine hard-drawn platinum wire, 4 or 5 feet long, was used as a suspension for a ballistic galvanometer, and exhibited peculiar phenomena. The steel needles were replaced by brass ones, and the peculiarities investigated. When the room was warmed the needles swung round nearly 70° for a few degrees rise of temperature, and remained in about the same position for further rise. If it was now cooled a few degrees (3° or 4° F.) they quickly returned to their initial position. The author has not found a complete explanation, but believes it to be due to unequal expansion, and loose contact amongst molecules, and has devised a simple mechanism to illustrate his meaning.

Remarks and suggestions were made by Prof. Perry, Mr. Lant Carpenter, and the Chairman.

"*On a Magnetic Potentiometer.*" By A. P. Chattock. Read by Prof. Reinold.

The "so-called" magnetic resistance between two points on a magnetic circuit may be expressed as the ratio of the difference of potential to the total induction passing from one to the other (provided there be no magneto-motive force between them). From the fact that the volume integral of induction through a wire helix of constant cross section is proportional to the average difference of potential between its ends, it follows that any alteration in that difference of potential will give rise to an electro-motive force in the helix proportional to that alteration. Hence, if the wire be connected to a ballistic galvanometer, the combination may be called a magnetic potentiometer. A helix is formed by winding wire uniformly on a piece of solid india-rubber or canvas gas-tubing, of constant cross section, using an even number of layers to avoid external inductive effects, and leaving a small space between the turns so as to allow the tube to bend without elongating. Experiments made to measure the difference of potential between the ends of a magnet gave satisfactory results. One end of the helix was held stationary at one end of the magnet, whilst the other was moved quickly to the other end of the magnet, and the resulting throw of the galvanometer observed. This was next done at two operations, and the sum of the two throws was very nearly equal to the first. The results can be reduced to absolute measure by passing the helix through a coil of n turns, bringing its ends together, and starting or stopping a current, C, in the coil, the resulting throw of the galvanometer being noticed. The magneto-motive force used in this experiment is $4\pi n$C.

An interesting discussion followed, in which Prof. Perry, Mr. Shaw, Prof. Ayrton, and Mr. Bosanquet took part, the latter mentioning a measurement of magnetic potential made by himself some years ago.

In consequence of the absence of Prof. S. P. Thompson, his paper on "Secondary Generators" was postponed till next meeting.

Influence of Temperature upon Spectroscopic Observations and Measurements.—G. Krüss.—On elevation of temperature all phenomena of absorption and emission are transposed, in case of glass prisms, towards the violet end of the prism, but in the case of quartz prisms towards the red. These displacements are generally the greater the more refrangible the regions of the spectrum in which they occur.—*Zeit. Anal. Chem.*

NOTICES OF BOOKS.

The Printing of Cotton Fabrics. Comprising Calico Bleaching, Printing, and Dyeing. By Antonio Sansone, late Director of the School of Dyeing at the Manchester Technical School. Manchester: Abel Heywood and Son. London: Simpkin, Marshall, and Co.; and Hamilton, Adams, and Co.

The appearance of this book cannot be pronounced uncalled for. So rapid have been the changes in the tinctorial arts, and so many and varied have been the improvements introduced, that the author is justified in pronouncing that hand-books written a few years ago are now somewhat out of date. Mr. Sansone in the present volume limits his attention to calico printing. Bleaching and dyeing are considered only in so far as they are subsidiary to printing, properly so called. The treatment of silks and of delaines, and other mixed goods, is also not included, though in the Appendix there are a few pages devoted to the printing of woollen tissues, in explanation of some very beautiful patterns sent to the author by M. Horace Kœchlin, of Alsace.

The work opens with a brief history of the art, from which we learn that Manchester is still the largest centre in the world for the production of printed cottons, the number of machines at work in the district exceeding five hundred. Still it is here admitted that the highest grades of printing are executed in Alsace, and that, in spite of the money expended over our schools of art for more than thirty years, "Paris still holds the monopoly for the production of designs, especially of those of the better class and of high artistic value." Surely this fact, taken along with others which have been from time to time noticed in the Chemical News, should lead us, as a nation, to enquire whether our methods of training, as well in art as in science, may not be fundamentally astray?

We note with great pleasure the unqualified statement that "indigo, although seriously threatened by Bäyer's discovery of the synthetic production of indigotine, is now as firmly established as ever, as the artificial product cannot be as cheaply produced as the natural dye-stuff." If we are wise, however, we shall not "rest and be thankful," but strain every nerve to improve the cultivation and the extraction of indigo, so as to furnish a better quality and a larger yield. It is, of course, known to the majority of our readers that indigo occurs in the plant in the state of a glucoside,—the *Indican* of Schunck,—which, by fermentation, is split up into indigo-blue and a peculiar sugar. In connection with this subject Mr. Sansone throws out an interesting suggestion. "It is a question," he writes, "after the indican has been extracted from the plants or leaves, with water containing a small amount of sulphurous acid or a bisulphite, in order to prevent fermentation, if a larger yield could not be obtained by decomposing the indican by means of weak sulphuric acid (as was at one time done in the case of madder for producing garancine), and utilise at the same time the sugar solution for producing alcohol."

It is commonly known that, in the fermentation-blue vats, mismanagement or the accidental introduction of an unwished-for ferment often leads to serious losses. In like manner, false fermentations are not unknown in the extraction of indigo, which in some cases injure the quality of the product, and in others greatly reduce the yield. Now in indigo-dye vats two methods have been brought forward to combat this evil. One process is the so-called hydrosulphite vat of Schützenberger and Lalande, which dispenses with fermentation altogether. The other effects fermentation by means of a pure cultivation not liable to occasion putrefaction.

In the extraction vat we have two parallel methods:—Mr. Sansone's proposal to split up the glucoside by means of sulphuric acid, or, on the other hand, fermentation effected by a pure thorough-bred culture. We trust that

the vast importance of the interests involved will lead our readers to pardon this seeming digression.

Bleaching, with reference to the preparing of pieces for the printer, forms the subject of the first division of the work. In addition to the ordinary process we find here a description of the Mather-Thompson process, that of Prof. Lunge, and of the electrical process of M. L'Hermite. The Mather-Thompson process is said to effect an economy in time and in water, and to punish the cloth less than does the ordinary method. The result, however, is considered not quite satisfactory for a madder-bleach.

We come next to a consideration of the wares used, which are classified as mineral colours, natural organic colouring-matters, coal-tar colours, mordants, dunging-materials, astringents, soaps, oils and oil-mordants, solvents, thickeners, and albumenoid matters. Under all these heads the substances mentioned are those now in regular use, the numerous natural dyes and coal-tar colours which have merely an experimental or a historical interest being omitted.

The manufacture of the different colours, &c., is not, as a rule, discussed at length. An exception must be noted as concerns the manufacture of extracts. The author points out that in the woods, as in indigo, the colouring-matter is generally present in the form of a glucoside; and here, too, he recommends its splitting up by sulphuric acid instead of fermentation. He recommends that more attention should be paid to this "splitting up," as well as to the quality of the water and to the method of effecting evaporation.

The list of mordants has, of late years, been considerably extended. This especially holds good as regards the compounds of chromium and antimony. We are surprised to see, under Copperas, no mention of the most common and extensive method for production,—*i. e.*, by the action of air and water upon the iron sulphide of the coal-beds, commonly known as "brass lumps."

We regret that the author—unlike Hummel, Crookes, Calvert, and in fact almost all writers on chemical technics in this country—recognises, and occasionally uses, the hydrometer scale of Beaumé. To this scale there is the great objection that it does not bear any simple relation to direct specific gravity. In addition there are two, if not three, discordant versions of Beaumé. In the comparative tables here given 50 B. = sp. gr. 1·532, whilst in another table before us it equals 1·490.

We now come to what may be called the most important part of the work, *i. e.*, the processes of printing. These the author divides into two main categories—the printed or direct, and the dyed colours. Under the first mentioned he includes the steam or extract styles, whether involving the use of coal-tar colours, of dyewood extracts, &c., or of mineral colours; the pigment styles, fixed by albumen; the oxidation colours, including aniline black, naphthylamine puces and greys, &c.; and, lastly, direct indigo printing.

Under the dyed colours appear the alizarine dyed colours (old madder styles); the Turkey reds, with discharges; the vatted indigo styles, the design being produced by resists or discharges; and, lastly, the manganese bronzes.

As an introduction to the description of the printing processes we find very practical instructions for testing the wares, mordants, &c., by sample printing, or, we might say, for the general arrangement and management of the laboratory of a print-works. To suit the tastes and requirements of different readers the receipts are given both in English and in French weights and measures. It must be remarked, however, that the receipts play here a less important part than in some works, being given not as hard-and-fast rules, but in illustration of principles.

The machinery and apparatus are, in a separate section, illustrated both with plates and with figures inserted in the text.

The Appendix contains a notice of the attempts made at applying electric action in printing processes, and a description of the patterns of printed woollens supplied by M. H. Kœchlin. The illustrative patterns—thirty-six on calico and six on woollen tissues—are well executed and instructive.

There are introduced nineteen plates and thirteen figures in the text.

Our opinion of this book is most emphatically favourable. It is both instructive and suggestive, and every person connected with the tinctorial arts will find his library incomplete winhout it.

Agricultural Research Association. Circular No. 6. Aberdeen. 1887.

The experimental farm of this Association is at Glasterberry, Peterculter by Aberdeen, and we are glad to see that, although a few disappointments have occurred, the experimental work is proceeding on the whole in a satisfactory manner. It is of course obvious that investigations such as are being carried on here, intended to be exhaustive and conclusive (like so many others before them), cannot be completed in two or three seasons; but it is thought that one or two of the points under examination can be considered better now than later on. The questions here referred to are those dealt with in the first line of the ten experimental plots, and may be stated as follows:—

"Which of the most approved grasses are most useful in regard to earliness, permanence, quantity, and quality of produce: are those deemed bad, really bad?"

Nine different grasses were experimented on, and the condition of each during the whole year was noted and plotted on a curve: three out of these nine,—viz., rye, cocksfoot, and fescue,—when combined in one diagram, are found to give a crop standing above the average line of freshness and healthy condition during the whole year.

The quantity of grass crop was very carefully estimated, and it is found that in every case the second year's crop is very much greater than the first year's, in one case—viz., fescue—the increase being from 5 cwts. to 2 tons 10 cwts.

Experiments made to find which month of the year is most suitable to sowing, showed unanimously that the practice of sowing in the early spring, viz., April, cannot be improved upon. Nature sows in the autumn, but she cannot do otherwise, and her aim of perpetuating the species is secured if "of fifty seeds she brings but one to bear."

Another series of experiments shows that the best depth for sowing grass is 1 or 1½ inches.

Other subjects are under investigation bearing principally on the everlasting question of artificial manures, about which so much has been written by eminent authorities, without even yet satisfying many agriculturists that the advice given is to be relied on. The reason of this apparent indifference to their own best interests is not far to seek: the farmers and stock raisers who are interested in growing good crops have been brought up, so to speak, on the rule-of-thumb principle, and, moreover, they have not the opportunity—and possibly but little inclination—to read what has been done in districts other than their own: the way therefore to make the practice of scientific agriculture universal is to "keep on pegging away," with many experimetal farms, in as many districts as possible, so that the farmers will have brought home to them the truth, that it *does pay* to use chemical manures.

Twenty-eighth Annual Report of the Inspector of Milk and Vinegar for the Year 1886. Boston: Rockwell and Churchill. 1887.

In the year 1884 the number of adulterated samples of milk was 40 per cent, and these were on the average reduced in value 25 per cent, either by adding water or

removing the cream. During the year 1886 the percentage of adulterated samples has been reduced to 18·55, so that it may be fairly admitted that the work done by this department has been of real value to the consumers of this universal article of food. Previous to making the analysis the specific gravity of all the samples is taken, and the approximate percentage of fat as given by Feser's lactoscope is also noted. The analysis is made in the ordinary manner.

The most important step taken during the year has been the attempt to suppress the practice of colouring milk, and it is believed that this is the first systematic attempt made in this direction by milk analysts in any country. The substance used for colouring the skim milk is known as *annatto:* many objections were found to the ordinary method for detecting and estimating this substance, so a process was devised which has after a considerable trial given good results. This process consists in leaving a strip of filter-paper suspended in milk which has been rendered alkaline by the addition of 5 per cent of a solution of carbonate of soda (1 part to 3 parts of water) for twelve hours: after that lapse of time the strip of paper is taken out and washed in cold water, when, if annatto be present in the milk, the paper appears of a pale salmon-colour; if dipped into a solution of stannous chloride the colour developed is decidedly pink. One part in 100,000 is distinctly perceptible by this means.

In the latter part of the Report we find a few pages devoted to the subject of oleo-margarine, more generally known under the name of butterine. A short description of the manufacture is given, and a further refutation is made of the some time popular idea that butterine is made from filthy materials, or that dangerous chemicals are used in its manufacture. As a matter of fact there is very little difference in the compositions of butter and butterine. With regard to digestibility there may be a slight balance in favour of butter, but for supplying the body with heat and muscular energy they are of equal value; and considering that fat is an absolutely necessary article of food, and that there is not enough butter to supply the demand, the man who has discovered a method of rendering a digestible fat equally palatable with, and selling at a price below that of butter, should be looked upon as a public benefactor.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—The letter of "F.C.S." in Chemical News, vol. lv., p. 223, raises a question which, in the opinion of many, is of great importance to our profession. It cannot be denied that there is a large number of persons possessed of little chemical knowledge and less general culture who occupy positions which should be filled by regularly trained and well-educated chemists, thus lowering the status of the whole body.

The profession of Chemistry is, in its line, as important to the public as that of medicine, pharmacy, dentistry, or law, and it is of general interest that the men entrusted with the analysis of food, drugs, poisons, &c., &c., and those who are placed in charge of large industrial enterprises, should be guaranteed worthy of confidence as much as the members of the professions named.

If the councils of the Chemical Society, Institute of Chemistry, and Society of Chemical Industry would take the matter up and decide on joint action, I think it very probable that a workable system of licence and registration could be agreed on, which would protect the public from inefficient practitioners and raise the status of the profession.

I hope you will open your columns to the opinions of others on this subject—I am, &c.,

Joseph Fletcher.

Dublin, May 14, 1887.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—The discussion as to the nature and utility of the Institute of Chemistry having been revived in your columns, it may not be out of place to relate an experience for which I can vouch personally. I have no desire to bring the names of individuals forward, but am prepared to give you, Sir, the fullest proofs of my statements. I have seen a letter from a practising analyst, who is F.I.C. and F.C.S., in which he quotes 7s. 6d. for the determination of silicon and phosphorus in pig-iron. Comment is of course superfluous, but it would be interesting to know whether the Institute has any power to check the practice of charging fees such as this. As an individual every chemist is a law into himself, but if Fellows of the Institute are equally untrammelled with outsiders, how can the interests of the profession in general be benefitted by the Institute?—I am, &c.,

Not an F.I.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 3, February 5, 1887.

Russian Chemical Society.—Session of April 3/15 1886.—M. E. Andreeff presented some remarks on the teaching of chemistry in the technical schools.

P. Latchinoff describes the choleidanic and pseudo-choleidanic acids, obtained by oxidising cholanic acid with nitric acids. The barium and silver salts and the ethylic ethers of these two acids have been prepared and analysed. The author communicated some new data on the solubility of cholanic acid in water, alcohol, and ether, and on its optical properties $[\alpha]_D = +56° 40'$.

MM. Mikhailoff and Chlopine made a preliminary communication on the gelatinous state of the proteic bodies.

J. R. Tarkhanoff finds that in its natural condition egg-albumen possesses a feebler rotatory power than the filtered albumen no longer containing gelatinous flocks and filaments.

M. Setchenoff remarked that on heating egg-albumen in a vacuum there are obtained gelatinous flocks not easily attacked by pepsine.

M. Socoloff has studied the action of weak alkalies upon nitro-ethane. He considers it proved that the group, NO_2, of nitro-ethane resembles neither the group NOO of the ethers of nitrous acid, nor the group NO_2 of the nitric ethers, and secondly that nitro-ethane is not a derivative of hydroxylamine.

P. Melikoff sent in a memoir on tiglic acid, which he has treated with hypochlorous acid, obtaining a mixture of two chloroxy-valerianic acids, distinguished by the properties of their zinc salts.

The same author discussed the properties of the chloroxybutyric and bichlorobutyric acids.

M. Sivoloboff described a method for determining the boiling-points of small quantities of liquids.

The fourth part of the journal contains a memoir by P. Orloff on an hexylic glycerin.

Session of May 1/13, 1886.

D. Pavloff communicated, from a letter by C. Winkler, some details on germanium.

He also announced, on behalf of M. V. Sorokine, that on heating isosaccharine with aniline, a compound is obtained, $C_{12}H_{17}NO_5$, in the form of crystalline needles, fusible at 165°.

E. Werner sent in an account of thermo-chemical researches on the substitution of hydrogen by bromine in the aromatic series.

M. Gadziatsky sent in an account of his researches on the isoprene of caoutchouc.

M. Favorsky announced that methyl-ethyl-acetylene (obtained by the action of alcoholic potassa upon propyl-acetylene) and the dimethyl-allylene (derived from trimethy-ethylene) enter into reaction with sodium if heated to 100° in sealed tubes.

M. Latchinoff made a communication on the isocholanic and isobilianic atids, obtained by the oxidation of the choleinic and choleic acids.

M. Kolotoff has obtained nitro-ethane by causing sodium nitrite to act upon potassium monochloro-propionate.

M. Rosenblatt sent in a method for the qualitative and quantitative determination of boric acid by means of methylic alcohol.

M. Poehl communicated the results of the analyses of Crimean wines.

M. Rassine sent in a memoir on the isomeric bromo-naphthalides.

The following researches were sent in from the chemical laboratory of the University of Kazan :—

Analysis of Mother-waters and of the Water of a Lake near the Springs of Stolypine, by P. Boulitch.

On Oxystearic Acids of different Origins, by A. and C. Saytzeff.

M. Wolkoff has pursued his researches on the action of high temperatures on the primary monatomic alcohols. If absolutely pure they are not decomposed, even at 200° to 300°, but traces of methyl iodide determine their decomposition.

G. Alibegoff made a communication on the compounds of uranium with oxygen and sulphur, and on the methods of separating and determining this element in presence of the alkaline and alkaline-earthy metals. The processes are not given.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 4.

Air-Analysis on a Novel Principle.—Otto Petterson —This memoir cannot be reproduced without the four accompanying illustrations.

Gas-Analytical Method. — Otto Petterson. — This memoir also requires the illustrations here given.

On Normal Solutions. — L. L. de Koninck.—The writer thinks that Winckler (who has since practically abandoned his proposal) might have done better if he had taken the molecule of hydrogen instead of the atom as the basis of his system.

Determination of Phosphorus in Iron and Steel.—E. F. Wood.—The author proposes two modifications in the direct molybdic method of Eggertz, which he considers as the best hitherto known. This paper will, if practicable, be inserted *in extenso*.

A Novel Method for Determining Fluorine Volumetrically.—Dr. F. Oettel.—An illustrated paper.

Separation of Zinc from Iron, Cobalt, and Nickel.—P. von Berg.—The author, at the suggestion of Prof. Ostwald, has attempted the separation of zinc from iron, cobalt, and nickel, by passing sulphuretted hydrogen into a formic or monochloracetic solution. In presence of only 3 c.c. of free formic acid (sp. gr. 1·2) and 360 c.c. water he obtained zinc sulphide free from any ponderable traces of iron. It is necessary to filter immediately after the treatment with sulphuretted hydrogen, as if it is allowed to stand some zinc sulphide is deposited. The liquid should be heated to 50° to 60°. After the solutions were duly diluted and heated they were mixed with a quantity of sodium formiate approximately equal to half the equivalent of the zinc sulphate present, and with the proportion of free formic acid (sp. gr. 1·2) and a slow current of sulphuretted hydrogen was then introduced until it became predominant. A large excess of sodium formiate is to be avoided. As soon as the liquid had partially settled it was filtered, the precipitate washed with sulphuretted hydrogen water to which about 1 per cent of free formic acid had been added, and the zinc sulphide was determined in the known manner. Zinc may also be successfully precipitated from a monochloracetic solution. The author proceeds in a very similar manner to that already described. As soon as the precipitation is completed and sulphuretted hydrogen predominates he filters at once without waiting for the liquid to become clear. Any portion of precipitate adhering to the side of the beaker is at once brushed off with a feather before it can dry. The precipitate is washed with sulphuretted hydrogen water, to which a little monochloracetic acid has been added.

Direct Separation of Manganese from Iron.—L. Blum.—This separation depends on the precipitation of manganese from an ammoniacal solution in which all the iron remains dissolved. Potassium ferrocyanide effects no precipitation in the ammoniacal solution of a ferric salt to which tartaric acid has been added, whilst manganese is thrown down from such a solution as manganese ferrocyanide. The blue deposit of iron ferrocyanide produced by potassium ferrocyanide in the acid solutions of ferric oxide, is decomposed on treatment with alkalies with separation of ferric hydroxide. If the solution in which the decomposition takes place contains a tartrate the ferric hydroxide is dissolved by the latter in its nascent state. Manganese ferrocyanide is not decomposed by ammonia. The separation is carried out as follows :—A hydrochloric solution containing ferric chloride and manganous chloride is mixed with so much tartaric acid that no precipitate appears on adding ammonia so that the reaction is strongly alkaline. The clear solution, containing ammonia in excess, is precipitated with potassium ferricyanide, when all the manganese is deposited as manganese ferrocyanide. If, in addition to manganese, nickel, cobalt, and zinc are present, they also are thrown down as the corresponding ferrocyanides. The precipitate filters badly, passing through the filter unless boiled, and even then the water passes through turbid on washing. The process, however, can be used qualitatively for the detection of traces of manganese in presence of much iron.

Syrmian Wormwood Wine.—M. Petrowitsch.—For this memoir we must refer the reader to the original.

The Determination of Tannin: A Proposal.—E. B. —After having tried in various modifications, but with unfavourable results, an entire series of the earlier methods for the determination of tannin, Gerland's with tartar emetic, Wolff's with copper oxide, Handtke's with ferric acetate, the author turned to Löwenthal's method as modified by Schrœder. But he could not obtained the "hide powder," needful for precipitating the tannin. Instead of hide powder or its substitutes (the gelatigenous tissue of bones and horn-cores) other precipitants have been used, such as bone-black, glue, and more recently gelatin and common salt. Instead of indigotine, the solution of extract of indigo has been recommended; the untrustworthiness has been shown by Von Schrœder. He also uses ferric acetate as the best means of recognising tannin. The author, in carrying out Handtke's method, found it impracticable as described, since the precipitation of the tannin is too tedious. The precipitation seems, however, complete i the reagent is used in excess. He prepared the solution from iron-ammonium alum, crystalline sodium acetate, enough to saturate the sulphuric

acid combined with the ferric oxide, and a little acetic acid; therefore: iron-ammonium alum, 48·2 grms.; crystalline sodium acetate, 25·0 grms., acetic acid containing 50 p.c. hydrate, 40·0 c.c., all dissolved to 1 litre. Of this solution there was added to Schrœder's tannin solutions or nut gall decoctions (of 5 grms. per litre) 10 c.c. to 50 c.c. of the tannin solution. After a quarter of an hour the author tested if everything was precipitated, which was always the case, made it up to 100 c.c., and filtered. Of the clear and generally greenish solution 20 c.c. were taken (=10 c.c. of the original solution), and after the addition of 20 c.c. solution of indigotine it was titrated with potassium permanganate. The number of c.c. obtained (consumed by matter other than tannin) were deducted from the total c.c. found in the first titration, and the remainder was taken as pure tannin.

Safe Method of Breaking off Glass.—E. Beckmann.—The author, in case, *e.g.*, of a combustion-tube, operates as follows:—At the part to be fractured there is made a short mark with a file. The tube is wrapped round with pads of moist filter-paper, so that there remains a track of 1 to 2 m.m. in width on both sides of the file-mark. If this space is heated over the Bunsen burner or the pointed flame of a gas blast, while the tube is made to revolve slowly on its axis; there is then formed a smooth ring-fracture in the direction of the file-mark, keeping the exact middle between the two pads. These pads are from 1 to 2 m.m. in thickness, and 2 to 4 m.m. in breadth with the folds turned towards the file-mark.

Chemical Characteristics of Beers produced with Pure Ferment Cultures.—E. Borgmann.—It is shown analytically that the two bottom ferments described by Hansen as distinct if introduced into the same nutrient liquid and under identical conditions effect clearly different chemical work. They differ, therefore, not merely botanically, but chemico-physiologically.

Titration with Weighing of the Liquid Consumed.—F. V. Pool.—From the Chemical News.

Contributions to Micro-chemical Analysis.—A. Streng and K. Haushofer.—Not suitable for abstraction.

A New Air Thermometer.—G. Grasi.—This apparatus, the arrangement of which is not described, not merely indicates, but measures temperatures to $\frac{1}{10000}$° C.

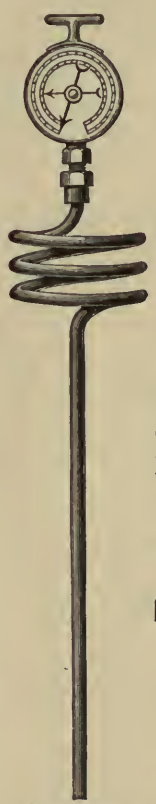
An Improved Thermo-electric Battery.—Clamond and Carpentier.—Noticed under *Comptes Rendus*.

MISCELLANEOUS.

The late Mr. E. O. Brown.—In our number for December 24th, 1885, we mentioned that a fund was being raised among the friends of Mr. Brown for the object of affording some aid to Mrs. Brown, who had four young children to provide for. We are happy to state that, in answer to these applications, subscriptions were received amounting to £937 11s., after deducting expenses, postage, &c., of £16 11s. 1d. Of the balance £435 was expended in the purchase of 4 per cent Stock of the Queensland Government, and £473 15s. in the purchase of Guaranteed 5 per cent Preference Stock of the Scottish Australian Investment Company, which will bring in an income of £35 per annum. The Stock was purchased in the names of Major C. D. Davies, John Spiller, and W. Y. Dent, who were appointed Trustees of the Fund for the benefit of the children of the late E. O. Brown, with discretionary powers to expend the sums at their disposal in such a manner as may seem to them most advisable, and to close the account at the expiration of twelve years from October 20th, 1886, the date of the Trust Deed, by which time the youngest child would be 18 years of age. The widow has received a grant of £100 from the War Office, and a gratuity of £50 from the Royal Society.

MEETINGS FOR THE WEEK.

Monday, 23rd.—Society of Arts, 8. (Cantor Lectures). "The Chemistry of Substances taking part in Putrefaction and Antisepsis," by J. M. Thomson, F.C.S.
Tuesday 24th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "The Modern Physiology of the Brain, and its Relation to the Mind," by Prof. Victor Horsley, F.R.S.
—— Society of Arts, 8. "The Importance of the Applied Arts and their Relation to Common Life," by Walter Crane.
Wednesday, 25th.—Geological, 8.
Thursday, 26th.—Royal, 4 30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "The Chemistry of the Organic World," by Prof. Dewar, F.R.S.
—— Telegraph Engineers, 8.
Friday, 27th.—Royal Institution, 9. "Etiology of Scarlet Fever,' by Edward E. Klein, M.D., F.R.S.
—— Quekett Club, 8.
—— Society of Arts, 8. "Indian Tea," by J. Berry White.
Saturday, 28th.—Royal Institution, 3. "Victorian Literature," by Prof. John W. Hales, M.A.
—— Physical, 3. "Note on Transformers for Electric Distribution," by Prof. S .P. Thompson, D.Sc. "On Magnetic Torsion of Iron Wires," by Mr. Shelford Bidwell, F.R.S. "On a Strain in a Beam fixed at Both Ends," by Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S.



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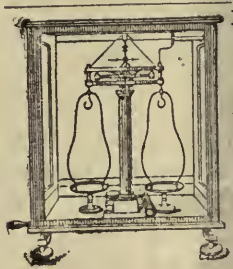

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THE CHEMICAL NEWS.

Vol. LV. No. 1435.

NOTES ON THE THYMOL AND MENTHOL SUGAR TESTS.

By DAVID LINDO.

These notes refer to some new sugar reactions described in a former paper. The alcoholic solutions of thymol and menthol employed in these experiments were the same strengths as those used in the former ones.

Five c.c. sugar solution,* 1 in 1000 water, were placed in a small beaker; half a c.c. thymol solution added, then 10 c.c. pure sulphuric acid (sp. gr. at 28° C. 1·813†) after about a minute; added 10 c.c. more sulphuric acid, and after another interval of a minute poured the product into 300 c.c. distilled water. The colour of the mixture was almost a pure magenta. Stirred well and before a precipitate had formed, removed 6 c.c.—equal to rather less than 0·0001 grm. of the sugar employed—and diluted this with 96 c.c. water. The pink colour was quite distinct, thus showing the presence of one part of sugar in a liitle more than one million parts of liquid. The volume under observation must, however, be borne in mind. No colour could be seen in a few c.c. of the fluid separated from the mass. The colour faded after two or three hours.

The precipitate having formed in the balance of the original liquid, it was filtered. The filtrate was free from colour, but the washings soon began to pass slightly tinged pink. The precipitate—of a very fine colour—was dissolved on the filter in a little alcohol, and the yellowish solution that resulted mixed with 25 c.c. water and 1 c.c. sulphuric acid. The purple colour was restored, but quickly destroyed on boiling, a small quantity of tarry matter separating.

The solution reacted persistently with sulphuric acid alone, giving a pink colour, which was no deeper when thymol was used with sulphuric acid to test it. The same results were obtained with a precipitate from a menthol product treated in a similar manner. Kingzett and Hake failed to obtain sugar from a camphor precipitate, operating, it would appear, on a much larger scale.

All such experiments, however, can be of little value unless tried on the precipitates in a state of purity. As they are not crystalline, but seem to be of a resinous character, there appears little prospect at present of obtaining them in a pure condition, or at least of being able to discriminate between a pure product and a mixture; otherwise heating in sealed tubes with dilute acid would be worth trying.

As menthol gives no reaction with nitrates or nitrites that could possibly be mistaken for sugar, it is in this respect—but only in this—more reliable than thymol as a test for sugars, or other carbohydrates that react like sugars. In the presence of nitrates or nitrites, however, in notable quantity, sugar cannot be detected by either of these reagents. As regards thymol this is not solely due to the confusion that results from both sugars and nitrates, &c., giving a purple-red colour with the test, but also to the fact that when nitrates, &c., are present in sufficient quantity, the sugar reaction either does not occur or the product is almost immediately destroyed, so that on diluting with water no characteristic colour will be obtained.

An aqueous solution of potassium nitrate, 1·8723 grms. in 100 c.c., was chiefly employed in these experiments, 1 c.c. = 0·010 grm. N_2O_5. When the N_2O_5 was equal in weight to the sugar present, pale pinks were sometimes obtained on dilution, not permanent, therefore not characteristic of sugar. With 2 parts N_2O_5 to 1 of sugar a greenish opalescence was observed; on dilution no trace of pink.

The same results were obtained with the same proportion of N_2O_5 to sugar, whether the sugar solution was 1 sugar in 400 water or 1 in 1600 water.

With 4 sugar to 1 N_2O_5 very fine pinks were obtained on dilution, permanent, and giving the same kind of precipitate which a weak solution of pure sugar always yields to the test (sugar 1 in 1600).

With menthol the sugar reaction was quite too obscure to be of any value, with equal parts of N_2O_5 and sugar the colour being ruddy brown whether the sugar solution was 1 in 400 water or 1 in 1600.

As the proportion of N_2O_5 is increased, the colour approaches yellow.

With 4 sugar to 1 N_2O_5 very good reds were obtained, but the colour not quite so pure as when N_2O_5 was absent (sugar 1 in 1600).

As 2 drops of thymol or menthol solution and 1 c.c. sulphuric acid give the same colour reactions, differing only in intensity with 0·5 c.c. sugar solution,—whether the latter is pretty strong or extremely dilute,—it would seem large excess of these reagents (especially sulphuric acid and thymol) does no harm. Large excess of sugar, however, as might be anticipated, is decidedly injurious.

Using of course 2 drops thymol or menthol solution and 1 c.c. sulphuric acid to 0·5 c.c. sugar solution, if the latter contains 2 per cent sugar no colour will be obtained by either test that can be recognised as derived from sugar after the mixture has stood a few seconds. On diluting the thymol a brown precipitate falls, and menthol soon changes to the same colour.

With 1 per cent sugar solution thymol gives a ruddy brown precipitate on dilution, not characteristic, and menthol soon acquires the same tint. Half per cent sugar solution, however, gives very fine reds with menthol, deep but permanent, differences in depth of colour—as in all cases—depending to a certain extent on variations in the temperature.

If alkaline chlorides or HCl have any influence in marring the delicacy of the tests, such experiments as I have made fail to show it.

Half a c.c. sugar solution, 1 in 40,000, gave as distinct a reaction with thymol when common salt to the extent of 400 times the weight of sugar was present as when it was absent; and deeper reds were obtained by diluting thymol products with pure strong HCl than by diluting with the same volume of water.

Half a c.c. sugar solution, 1 in 20,000, gave as good a reaction with menthol, in the presence of NaCl to the extent of 200 times the weight of sugar, as when the salt was absent.

These experiments have been repeated, but not carried further. The results indicate pretty clearly that HCl or alkaline chlorides may be present in very large proportion without injuring the delicacy of the tests.

If a thymol product diluted with water is mixed with alkali in excess, the colour changes to yellow.

Strong HCl cannot be successfully substituted for sulphuric acid in these experiments. The acid employed to test this contained 30·30 per cent HCl. Using even 2 c.c. in place of 1 c.c. sulphuric acid with half c.c. sugar solution, no colour could be obtained at ordinary temperatures, with either thymol or menthol, using so strong a sugar solution as 1 per cent. On heating, the colour with menthol was not pure red, but yellowish red, the same with sugar 1 in 1000 water; at this dilution the colour was faint.

With thymol there was no difficulty in getting reds down to 1 sugar in 5000 water, but the colour was always weak and dingy.

Falmouth, Jamaica, B.W.I.,
April 25, 1887.

* Cane sugar was used in all the experiments.
† The same acid used in all the experiments.

GRIQUALANDITE, A PSEUDOMORPH OF CROCIDOLITE.

By G. GRANT HEPBURN, University College, Dundee.

THIS mineral, which was recently received from a resident in Port Elizabeth, occurs in large quantities on a farm in Griqualand West, South Africa, and appears to be a pseudomorph after crocidolite, which it resembles exactly in structure. Its composition, however, is different from ordinary crocidolite, as it contains no soda, and has practically the whole of its iron in the ferric instead of in the ferrous condition.

It occurs as opaque, asbestos-like fibres, which are non-elastic and of a snuff or golden brown colour. These fibres are arranged perpendicularly between two thin layers, one of galena, and the other of a very dense and extremely hard substance, consisting chiefly of silica, iron, and magnesia. The mineral is in places penetrated by very fine veins of galena.

It has a specific gravity of 3·136, and in hardness lies between 4 and 5, but is very nearly 4. The streak is the same colour as the mineral, viz., golden brown.

When powdered and heated to 120° C. it changes colour from brown to dark red. On cooling, the dark red gives place to a bright red, which is permanent. A splinter of the mineral heated strongly before the blowpipe is infusible, but becomes magnetic and assumes a logwood-red colour.

An analysis gave the following results, from which it appears that it has the composition of a ferric silicate, having the formula, $6SiO_2 \cdot 4Fe_2O_3 \cdot 5H_2O$:—

	Found.	Calculated for $16SiO_2 \cdot 4Fe_2O_3 \cdot 5H_2O$.
SiO_2	56·75	56·80
Fe_2O_3	37·64	37·87
H_2O (combined) ..	4·96	5·33
FeO..	1·09	—
MgO	0·10	—
H_2O (moisture) ..	0·27	—
	100·81	100·00

The combined water is a little too high, otherwise it would correspond exactly to the formula $H_2O \cdot Fe_2O_3 \cdot 4SiO_2$, which is that of an acid ferric silicate, thus :—

$$4H_2SiO_3 = H_8Si_4O_{12}$$

$$Fe_2^{iv}H_2Si_4O_{12} = H_2O \cdot Fe_2O_3 \cdot 4SiO_2.$$

Wibel (*Berichte der Deut. Chem. Ges.*, vi., 185) gives the analysis of a mineral having a very similar composition.

In the following table the properties of crocidolite are placed side by side with those of griqualandite :—

Griqualandite.	Crocidolite.
Specific gravity = 3·136.	Specific gravity = 3·2 to 3·265.
Colour and streak, golden brown.	Colour and streak, lavender blue to leek green.
Non-elastic.	Somewhat elastic.
Infusible.	Melts easily to a somewhat frosty glass.
Borax bead, brown.	Borax bead, green.

Determination of the Water in Crystalline Boric Acid.—E. Hintz and H. Gilbert.—The author puts 1·5 grm. commercial caustic lime in a platinum capsule, ignites before the blast until the weight is constant, pours on the lime about 10 c.c. of water, stirs 2 grms. boric acid into the milk of lime with a glass rod, washes the matter adhering to the rod into the capsule, and evaporates on the water-bath to dryness. It is then heated at first with a small flame, then with a full one, and lastly, in order to expel any carbonic acid, for five minutes before the blast. The loss of weight represents water, and in Tuscan samples water *plus* ammonia.—*Zeit. Anal. Chem.*

AN INTERNATIONAL HYDROMETER.

By FRANK SPENCE.

THE idea that the specific gravity of a solution and its strength, or proportion of dissolved constituent, are equivalent things, is a popular fallacy. This is evident from the following facts:—

Relative proportions of Sulphate of Alumina dissolved in a given volume of water.	Corresponding indications by specific gravity Hydrometer (Water = 1·00).
10	1·05
20	1·10
30	1·15

Thus, in the column of proportions of substance dissolved, the last figure is three times the first; whereas, in the corresponding column of specific gravities, the last figure is only one-tenth more than the first.

It follows that a workman using a specific gravity hydrometer to ascertain the strength of the liquids with which he is operating, would be entirely misled by its indications. Hence has arisen the necessity for hydrometers directly indicating strengths.

But a perfect hydrometer should show not only the strength of solutions, but their gravity as compared with that of water—the universal standard—or, in other words, their "specific gravity."

Baumé's, Cartier's, and Beck's strength-hydrometers have all arbitrary and artificial scales, and their figures cannot be reduced to the corresponding specific gravity ones without the use of tables. Baumé's, for example, is based upon the highly abnormal indications shown by solutions of common salt.

Twaddell's hydrometer has a normal scale, and a uniform though distant relationship to specific gravity, his figures being reducible to the corresponding specific gravity ones by multiplying them by 5, adding 1000, and placing a decimal point on the right of the left-hand figure. On account of this remote relationship to specific gravity, Twaddell's hydrometer cannot be proposed to French and German chemists as a standard for unifying the scales of different countries.

The International Hydrometer indicates at once both the strength and the specific gravity, and is based upon the very simple principle of subtracting from the specific gravity scale the figure 1·00 for the constant—water—and leaving the remaining proportional figures on the instrument to indicate to the workman the regularly increasing or decreasing strength. The instruction, printed on each instrument, "For specific gravity add 1·00 (Water)," likewise enables the director of an establishment to perceive, in an instant, what is the specific gravity, should he require to know it, or to compare it with any other specific gravity figures.

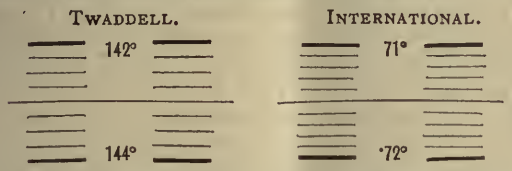
For liquids lighter than water the converse arrangement is adopted; the figures on the scale showing the workman the progressively increasing degrees of "lightening" instead of "weightening," or, in other words, the progressively increasing proportion of "lightening" substance present. At the same time, the words on the instrument "For spec. grav. deduct from 1·00 (water)," enable the chemist, in a moment, to ascertain the specific gravity of the liquid.

The advantages resulting from the unification of the heat-measuring scales of all nations are now universally recognised, and every advanced chemical and metallurgical establishment, at home and abroad, has adopted the French Centigrade thermometer. The desirability, if not necessity, of unifying the discordant scales for measuring the strength of liquids, is equally obvious to the scientific manufacturer, and this object is now proposed to be accomplished by a scale which indicates at once both the strength and the specific gravity.

No. 1 hydrometer covers the range from 1·00 (water) up to and inclusive of 0·10 additional sp. gr. No. 2 covers

the range from 0·10 up to and including 0·20 additional, and so on. Similarly, with liquids lighter than water, No. -1 hydrometer covers the range of figures up to and including 0·10 lighter than water; No. -2, the range from 0·10 lighter up to and including 0·20 lighter, and so on. Thus, any manager or foreman requiring a hydrometer to test a liquid of supposed strength, knows in a moment which No. of instrument to send for; whereas, with Twaddell's and other hydrometers, probably not one person in fifty using them could tell off-hand what range the different Nos. of instruments cover.

Another practical advantage possessed by the instrument is the facility with which the eye can read off its indications—all the strengths shown by the three figures of Twaddell's scale being indicated by two figures on the stem of the International Hydrometer, thus:—



N.B.—It should be borne in mind that the solutions of few if any substances give, throughout, strength-hydrometer indications corresponding *exactly* with the proportions of dissolved constituent. New combinations of the solvent with the dissolved substance, forming at different strengths, or other causes, produce, at these strengths, expansion or contraction of the liquid and consequent aberrations in the scale. Strength-hydrometers are, however, for all practical purposes, regarded as indicators of the regularly increasing or decreasing gradations of strength, which would be shown by the solutions of a perfectly normal substance.

Manchester, May 16, 1887.

DETECTION AND ESTIMATION OF THALLIUM IN PLATINUM.

By H. N. WARREN, Research Analyst.

HAVING recently had occasion to heat to redness a number of platinum wires, of different dimensions, I was considerably struck with the intense greenness which several of the wires communicated to the flame of the Bunsen, and at once urged the heat to whiteness by means of a blast burner, and examined it spectroscopically. The light produced consisted exclusively of a single green ray, and was unmistakably characteristic of the metal thallium.

Of the wires submitted to analysis the thinner ones gave by far the most intense flame, apparently owing to the heat being better able to effect the softening of the metal. Samples of platinum foil were also subjected to similar tests, and in the majority of cases they gave a slight green colouration to the flame, although in some cases there seemed apparently a total absence.

I next submitted samples of the same wires to a careful gravimetric analysis, taking 10 grms. of each sample, and dissolving the same in pure aqua regia; after evaporating to dryness on a water-bath the dry residue was redissolved in a small quantity of distilled water, and slightly acidified with pure nitric acid; a few drops of hydriodic acid were next introduced, in order to precipitate the thallium as thallic iodide. The small precipitate obtained was digested for several hours over the water-bath, filtered, and well washed with pure alcohol to remove any free iodine that might contaminate the precipitate. The washed precipitate was then detached from the paper by means of a small quantity of alcohol, and received in a weighed platinum dish, which was afterwards dried at 100° C. until the weight remained constant, and the percentage of thallium present calculated from the weight obtained. This, in more than one case, although trifling, amounted to 0·1 per cent, and averaging from 0·02 to 0·1 per cent, the samples of wire containing by far the largest quantity in comparison with those of the foil.

A similar investigation was performed with several samples of platinum ore, in all of which distinct traces of thallium were obtainable.

Experiments were also performed as regards the action of thallium when alloyed with platinum. The result was that 0·5 per cent rendered the platinum absolutely useless for manufacturing wire from, rendering it decidedly brittle; and even 0·1 per cent considerably impaired its tensile strength and durability, whereas 2 per cent only induced the metal to fuse readily at a red heat.

THE INFLUENCE OF NITRATE OF SODA ON GUN-COTTON.

By F. NETTLEFOLD, F.C.S.

THE hygroscopic effect of nitrate of soda in gunpowder making is also felt in making gun-cotton charges. And since this substance alone does not appear to have the property to the same effect, the following experiments were made with a view to show the reason of the anomaly.

Gun-cotton primers were made $1\frac{1}{4} \times \frac{7}{8}$ in. with 30 per cent nitre—

1. With lime in small quantity, as required by the Government, and 30 per cent KNO_3.
2. With lime and 30 per cent $NaNO_3$.
3. No lime and 30 per cent $NaNO_3$.

It being suggested that lime might act as a carrier of water, by conversion to nitrate, reacting under the influence of water.

The experiments were conducted in three series—

1. In the open air in a damp place for 200 hours.
2. " " " 170 "
3. In a closed damp vessel for .. .. 100 "

Increase in Weight and Water Absorbed, Per cent of Original Weight taken.

SERIES I.

No. of hours.	No. 1.	No. 2.	No. 3.
12	−0·55	+ 1·4	+ 1·25
36	−0·66	+ 3·17	+ 2·20
70	+1·78	+ 2·31	+ 2·40
120	+1·22	+ 7·99	+ 8·08
195	+8·4	+21·40	+15·30
Loss or gain on the dry charge at end of expt.	−8·5	+ 2·3	1·9
Water contained at end of experiment	7·92		

The noticeable point in this table is that the potash charges decrease in weight at first, owing to the decomposition and efflorescence of nitre being more rapid than the weight of water absorbed.

The increase in dry weight of the soda primers cannot be accounted for.

SERIES II.

No. of hours.	No. 1.	No. 2.	No. 3.
20	0	+ 1·98	+ 1·98
50	−0·15	+ 2·30	+ 2·42
100	+3·03	+11·30	+11·12
173	+3·10	+22·30	+22·15
Loss or gain on the dry charge at end of expt.	−3·46	+ 0·01	+ 0·15
Water contained at end of experiment	6·83	22·42	22·3

Series III.

No. of hours.	No. 1.	No. 2.	No. 3.
24	+0·1	4·8	4·04
98	+0·2	13·91	15·4
Loss or gain on the dry charge at end of expt.	−4·4	+ 0·4	+ 1·3
Water contained at end of experiment	+4·9	+14·0	+ 17·0

The hygroscopic property of sodic nitrate is here clearly seen in all three cases to be greater than potassic nitrate.

The following figures tend to show what changes take place in the gun-cotton, under conditions which approximate to natural atmospheric conditions, usually found in damp mines:—

Series I.

No. 1.

	Before Expt.	After Expt. Calc. on primer.	Calc. on original wt.	Diff.	Change in dry weight.
KNO_3.. ..	31·3	28·7	26·26	−5·04	−8·5
Soluble salts	31·4	31·40	29·73	−1·67	
KNO_2.. ..	—	0·35	—	+0·35	
Gun-cotton	66·75	65·30	59·75	−7·67	
Alkali K_2CO_3	—	1·7	1·55	+1·70	

(For a loss of gun-cotton of 7·67 there is a corresponding loss of nitre of 5. But it would require 4·65 of nitre for complete combustion, and the 0·35 of KNO_2 might make up the difference).

No. 2.

$NaNO_3$ ..	25·6	21·70	21·21	−4·49	+2·3
Soluble salts	—	23·4	22·87	—	
Gun-cotton	72 8	74·37	72·70	−0·10	
$NaNO_2$ ..	—	0·26	0·26	+0·26	
Na_2CO_3 ..	—	0·11	0·11	+0·11	

(The nitrate of soda has a tendency to effloresce from the surface of the primers more than the nitrate of potash; hence the loss, while the gun-cotton does not vary much).

Series II.

No. 1.

KNO_3.. ..	31·3	31·4	30·31	−0·99	−3·46
Soluble salts	31·65	32·0	30·89	−0·76	
Gun-cotton	66·75	65·37	63·11	−3·64	

(3·64 per cent gun-cotton would require for complete combustion 2·2 per cent KNO_3. But as the soluble salts do not increase, it probably decomposed with a lower proportion).

No. 2.

$NaNO_3$ ..	25·6	21·6	21·6	−4·0	0·01
Gun-cotton	72·83	72·0	72·0	−0·83	

(Here the sodic nitrate is alone altered).

Series III.

No. 1.

KNO_3.. ..	31·3	32·42	30·99	−0·31	−4·4
Soluble salts	31·65	33·73	32·23	+0·58	
Gun-cotton	66·75	62·94	60·17	−6·58	

(Similarly to No. 2, Series I., the loss of gun-cotton has taken place without a sufficiency of nitre and the increase of alkalies).

No. 2.

$NaNO_3$ ..	25·6	21·31	21·4	−4·2	+0·4
Soluble salts	24·26	—	—	—	
Gun-cotton	72·83	73·2	72·9	—	
Na_2CO_3 ..	—	0·23	0·23	+0·23	

It is noticeable that the nitrate of soda is lost to about 4 per cent without oxidising a relative amount of gun-cotton, and in the potash charges that there is a loss which is apparently accounted for in the above figures by destruction of gun-cotton.

QUALITATIVE DETERMINATION OF SULPHITES IN PRESENCE OF HYPOSULPHITES AND SULPHATES.

By M. A. VILLIERS.

On treating a solution of a neutral alkaline sulphite with barium chloride, we obtain, by double decomposition, insoluble neutral barium sulphite and an alkaline chloride, and the liquid, which was strongly alkaline at first, becomes exactly neutral to litmus.

If we treat a solution of an alkaline bisulphite with barium chloride, there is still formed neutral barium sulphite, and half the sulphurous acid remains in solution.

Hence it results that if we treat with chloride of barium a mixture of an alkaline sulphite and bisulphite, a mixture which has a distinctly alkaline reaction, even when the proportion of neutral sulphite is small, the solution becomes acid after the addition of the barium chloride, and contains free sulphurous acid.

Upon these facts may be founded an expeditious and convenient process for the detection of sulphites in presence of hyposulphites, which, like the sulphites, evolve sulphurous acid by the action of acids. It is sufficient to neutralise the solution of the mixed salts with hydrochloric acid, if the mixture is alkaline, carefully avoiding any excess of acid, and to precipitate then with barium chloride. The liquid which becomes acid and contains sulphurous acid is then distilled. The sulphurous acid passes over in the first portions of the distillate, and may be recognised. The filtrate may further be treated with iodised potassium iodide and examined for sulphuric acid. The same process is applicable in presence of salts of the thionic series, which evolve sulphurous acid by the action of acids.— *Comptes Rendus*, vol. civ., p. 1177.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending April 30th, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To The Water Examiner, *Metropolis Water Act*, 1871.

London, May 5th, 1887.

Sir,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the same and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from April 1st to April 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

In the supply to the Metropolis for the past month, the proportion of organic matter present in the water has continued uniformly low; though not, indeed, so remarkedly low as in the previous month's supply. Thus, the maximum proportion of organic carbon in any sample

of Thames-derived water was 0·179 part in 100,000 parts of the water; with a mean of 0·162 part in the entire series of samples, as against a mean of 0·172 part for the previous three months' supply.

One only of the Thames-derived samples had to be recorded as otherwise than clear and bright; but several samples of the East London Company's water, drawn from a stand-pipe in the Commercial Road, were found to be "very slightly turbid" from the presence of finely-suspended mineral matter, apparently detached from the lining deposit of the mains in that neighbourhood by exceptional flushings to which they had been subjected. The maximum proportion of organic carbon found in this Company's supply was 0·147 part in 100,000 parts of the water.

We are, Sir,
Your obedient Servants,

William Crookes.
William Odling.
C. Meymott Tidy.

IN MEMORIAM.

One of the most brilliant luminaries of French science has latterly disappeared from our view. On the eleventh of the present month Boussingault—next to M. Chevreul the *doyen* of the Academy of Sciences—closed his long and honourable career, and at the advanced age of 85 has gone to his rest.

We first hear of him in the scientific world as far back as 1821, when, at the age of nineteen, whilst a student at the Mining School of St. Etienne, he published a memoir on the compounds of platinum and silicon.

Shortly afterwards he was appointed by the Spanish government to a professorship at the Mining School of Bogota, and accordingly set out for South America. Here he threw himself with ardour into his new duties, but on the outbreak of the revolt which ultimately deprived Spain of all her domains on the American continent, he allowed himself to be led away, joined the insurgents, and became attached to the staff of Bolivar. After the war was at an end he became superintendent of the mines of Colombia. In his various capacities he traversed the regions of Venezuela, New Grenada, and Bolivia, and displayed a wonderful activity. Amidst all the distractions of his military and official duties he carried on researches in physiography, chemistry, mineralogy, and geology, and acquired the reputation of a not unworthy successor of Humboldt. More than fifty memoirs written during this epoch remain to attest his zeal for science.

On his return to France he was appointed to a chair at the Conservatoire of Arts and Manufactures in 1837. In 1837 he became a member of the Academy of Sciences, a member of the National Society of Agriculture in 1842, whilst in 1844 he was appointed a member of the Council of Hygiene.

His attention seems to have been drawn to agricultural chemistry in consequence of his marriage with Mlle. Le Bel, the sister of an eminent agriculturist. In conjunction with his brother-in-law he began on the estate of Bechelbronn those series of experiments which have since rendered this name classical. It may fairly be said—as was admitted at the Congress of Moeckern—that he was the creator of agricultural stations and of the system of continuous experimentation on a practical scale to determine the best conditions of the growth of crops. He afterwards continued his experiments at Liebfrauenberg, a domain on the slopes of the Vosges where he completed a number of the most important researches on the atmosphere and the soil, on the gaseous exchanges between the air and the plant during the fixation of carbon, and on nitrification. In the midst of these experiments he still continually reverted to his former studies, to geology, metallurgy, and terrestrial physics.

Sanitary questions occupied a great and latterly an increasing share of his energies. He studied the influence of poisonous matters upon miners and manufacturers, and busied himself with means for their protection. More than thirty years ago he drew the attention of the authorities to the dangerous character of the waters drawn from wells for the supply of Paris. He was also concerned in improving the sewers of Paris and with the utilisation of sewage and of all animal refuse.

On the occasion of his funeral, on the 14th inst., the customary discourses were pronounced by M. Schlœsing, on behalf of the Academy of Sciences, and by M. Troost, as representative of the Council of Public Health.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, May 19th, 1887.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. S. F. Benford, Edgar Hall, J. S. Jackson, and Hugh Gordon were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William Bott, Ph.D., Owens College, Manchester; William Nathaniel Evans, 66, Stackpole Road, Bristol; Khasberao B. Jadhara, Baroda, Bombay Presidency, India; J. M. Kavanagh, Victoria Mill, Herbert River, North Queensland; John T. Sheard, Gas Offices, Bloom Street, Salford; Henry Livingstone Sulman, 13, Brewster Gardens, St. Quintin Park, W.; Frederick Percy Watson, 31, Carholme Road, Lincoln.

The following papers were read:—

46. "*The Formation of Hyponitrites.*" By Professor Dunstan and T. S. Dymond.

Zorn (*Ber.*, xv., 1258) has stated that alkali nitrites and nitrates are readily acted on by ferrous hydroxide, forming hyponitrite, ammonia, nitrogen, and nitrous oxide. Divers and Haga (*Trans.*, 1884, 87, and 1885, 364) allege that alkali nitrites yield much ammonia, but neither hyponitrite nor hydroxylamine, nor any gaseous product; and that alkali nitrates are wholly unaffected: while nitric oxide in presence of alkali is to a large extent converted into ammonia by ferrous hydroxide, but yields no hyponitrite.

The authors find that nitric oxide in the absence of alkali is reduced by ferrous hydroxide to nitrous oxide and nitrogen; no ammonia or hyponitrite is formed. In the presence of an alkali (sodium hydroxide) nitric oxide is partly reduced to nitrous oxide and nitrogen, and partly absorbed: the solution contains hyponitrite and ammonia, but on standing with excess of ferrous hydroxide it evolves nitrogen, and the hyponitrite disappears. The amount of hyponitrite formed depends within certain limits on the quantity of alkali which is present, on the quantity of ferrous hydroxide used, and on the time during which action is allowed to proceed. When three formula weights of ferrous hydroxide, $Fe(OH)_2$, and one of nitric oxide are used, the quantity of hyponitrite formed increases with each formula weight of sodium hydroxide that is added. About 20 per cent of the nitric oxide may be converted into sodium hyponitrite.

Alkali nitrites and ferrous hydroxide readily interact, producing nitrogen, nitrous oxide, ammonia, and hyponitrite. The amounts which are formed of these substances depend on the quantity of ferrous hydroxide used, and also on the time during which the action continues. Excess of ferrous hydroxide after some time converts sodium nitrite entirely into nitrogen and ammonia. As a lecture experiment, it is recommended to dissolve 5 grms.

of ferrous sulphate in about 25 c.c. of water, and to precipitate the liquid with sufficient of a 10 per cent potash or soda solution to leave the mixture faintly alkaline; 1 grm. of sodium nitrite dissolved in about 25 c.c. of water is then added, and the mixture stirred. After effervescence has ceased, and the liquid has stood for about half an hour, it is filtered. If the filtrate is diluted with an equal volume of water, and carefully neutralised with acetic acid, on the addition of silver nitrate a pale yellow precipitate of silver hyponitrite (mixed with some silver nitrite) will be obtained. Or a few drops of a silver nitrate solution may be added to the liquid before neutralisation; but in this case the precipitate will rapidly darken in colour. Alkali nitrates are hardly at all affected by ferrous hydroxide; small quantities are slowly converted into ammonia.

In explaining their results, the authors draw attention to the simultaneous formation of hyponitrite and hydroxylamine when sodium amalgam acts on dissolved sodium nitrite. They show that the ammonia is not derived from a further action of sodium amalgam on the hyponitrite, which yields only nitrogen. Similarly, ferrous hydroxide liberates nitrogen from sodium hyponitrite, but no ammonia is formed.

They consider that the action of sodium amalgam on a solution of sodium nitrite is best explained by supposing that the sodium nitrite combines with two hydrogen-atoms, forming $NaN(OH)_2$.

This compound may decompose, yielding hyponitrite: $NaN(OH)_2 = NaNO + H_2O$; or it may undergo reduction, yielding hydroxylamine,—

$$NaN(OH)_2 + 2H = NaOH + NH_2OH,$$

and also ammonia and nitrogen,—

$$4NaN(OH)_2 + 10H = 4NaOH + N_2 + 2NH_3 + 4H_2O.$$

Ferrous hydroxide, it is suggested, acts in the same way; being a substance which will combine with the hydroxyl of water when sodium nitrite is present to unite with the hydrogen. Any hydroxylamine which may be formed will at once be converted into ammonia by ferrous hydroxide. The authors find that when excess of ferrous hydroxide is used, and nitrogen and ammonia are the only products, the reaction takes place almost exactly in accordance with the equations—

(i.) $4NaNO_2 + 8OH_2 + 8Fe(OH)_2 = 4NaN(OH)_2 + 8Fe(OH)_3$;

(ii.) $8NaN(OH)_2 + 6OH_2 + 14Fe(OH)_2 = 8NaOH + 3N_2 + 2NH_3 + 14Fe(OH)_3$.

Since nitric oxide in presence of alkali yields exactly the same products as nitrites, the change can be most readily explained in the same way, assuming that the compound $NaN(OH)_2$ is first formed.

47. "*Ozone from Pure Oxygen.*" By W. A. Shenstone and J. Tudor Cundall.

The authors describe an apparatus in which oxygen has been prepared and stored without the possibility of air gaining admittance. So far as it is possible to determine the purity of the gas by tests, it would appear certain that it has contained at most 1-5000th of nitrogen. The oxygen has been collected and sealed up in glass tubes containing phosphoric oxide, in contact with which it has been kept for periods ranging from eight weeks to eight months. Subsequently it has been submitted to the action of electricity, and the ozone produced has been measured. In one experiment made at 10° C. no less than 11·7 per cent of the oxygen taken was converted into ozone. This is a very considerably higher proportion than has been obtained either by Brodie or by the authors from ordinary oxygen when similar means of electrification are employed, but not so high as was obtained by Andrews and Tait, who, however, worked in a different way, and the exact value of whose results is uncertain in consequence of the tendency of the sulphuric acid that they used in their gauges to absorb ozone.

The action of dry ozone on dry mercury has also been studied. Dry ozone from pure oxygen is decomposed in the well-known manner by pure and dry mercury, but without visible oxidation of the mercury. Further, when a definite volume of oxygen is ozonised and afterwards left in contact with mercury for many hours, the oxygen almost entirely recovers its original volume, the small differences observed between the initial and final volumes being probably due to the difficulty of measuring oxygen with accuracy in a tube partly coated with mercury.

The authors point out that the apparently high yield of ozone obtained under somewhat unfavourable conditions as to temperature may be due—

1. To the absence of nitrogen, the presence of which Andrews has shown is, under some conditions, very unfavourable to the production of ozone.
2. To the character of the electric discharge, which is most free from large sparks when the air and glass surfaces from which the discharge takes place are free from moisture.

The paper concludes with a note on the character of the silent discharge of electricity in ozone generators of the Siemens type, the influence of dryness on the character of the discharge being discussed.

Very full details are given of the method they now employ for preparing and storing pure oxygen. The method might readily be adopted in the case of other gases that do not attack mercury. The apparatus was chiefly constructed for the production of pure gases for various other experiments on the action of electricity on gases that are still incomplete.

48. "*The Volumetric Relations of Ozone and Oxygen.*" A Lecture Experiment. By W. A. Shenstone and J. Tudor Cundall.

Soret and Brodie have shown that if v be the contraction produced on the electrification of a mass of oxygen, then $2v$ will represent the further contraction that will occur on absorbing the ozone formed by means of turpentine. If it be true that ozone completely dissolves in turpentine, this indicates that three measures of oxygen are concerned in the formation of two measures of ozone. The authors describe an apparatus which they have constructed for readily exhibiting Soret's observation to a class.

Discussion.

The President said that he had been accustomed to join tubes *in situ* in the manner described by Mr. Shenstone. He added that it was possible to join together two different kinds of glass by means of a little soft white enamel, such as could be obtained from Powell's.

Mr. Fairley had also joined tubes in the manner described by the authors: calling attention to Brodie's ozonising apparatus, he remarked that the tube used by Brodie was probably thinner than was used by the authors.

Dr. Armstrong thought that the results of the authors' experiments on the action of mercury on ozone were a valuable contribution to our knowledge of the influence of minute amounts of third bodies on the course of chemical change. He suggested that it was important, if possible, to determine the extent to which oxidation took place in presence of varying minute amounts of moisture, in order to ascertain if this exercised an influence comparable with that exhibited in Prof. H. B. Dixon's experiments on the rate of propagation of the explosive wave in a mixture of carbonic oxide and oxygen.

Mr. Shenstone said that experiments such as were suggested by Dr. Armstrong, although very difficult with mercury, might probably be carried out with silver, which effected the decomposition of ozone with extraordinary facility. In reply to the question put by Mr. Page, he was quite unable to account for the peculiar condition assumed by the mercury when submitted to the action of the ozone. He had not been successful in joining tubes with the aid of the enamel spoken of by the President, but, on the other hand, had found it easy to join even

combustion tubing to soft glass by means of an oxy-hydrogen jet.

49. "*On the Thermal Phenomena of Neutralisation and their Bearing on the Nature of Solution and the Theory of Residual Affinity.*" By S. U. Pickering.

In dilute solutions the heat of neutralisation of an alkali is a constant quantity, independent of the nature of the alkali; and the majority of acids give the same results with any given base, whence it follows that M,R,Aq − M′,R,Aq = M,R′,Aq − M′,R′,Aq, where M and R are electropositive and electronegative radicles respectively. Each term of this equation is made up of two quantities, M,R (heat of formation of the salt molecule) and MR,Aq (true heat of dissolution of the salt), and it is impossible that such a relationship should exist were these actions independent of each other; they must be part of one quantity, and as M,R is a chemical action, so also is MR,Aq. The affinity of M and R are not entirely saturated by their combination with each other, and it is only by the further combination of the compound with water that saturation becomes complete. The equation can obtain only if the water satisfies the residual affinity of either the non-metallic or the metallic atom, and in the event of atomic valencies being whole numbers all the terms of the equation will be equal, whereas if these valencies are not whole numbers the equation will be made up of two pairs of equal terms.

The recognition of the heat evolved in any action being an absolute measure of the affinities saturated is necessitated by a study of these thermal results.

The few cases in which acids have a higher heat of neutralisation than the majority may be explained by their residual affinity being in excess of that which water can saturate; while in those cases where abnormally low results are obtained the salt is probably partially dissociated by the water.

Owing to the heat of neutralisation being independent of the nature of the base, it follows that the heat of formation in solution of similar salts of two different metals differs by a constant quantity, whatever the non-metallic radicle may be.

Discussion.

With reference to the hypothesis submitted to the Society in 1885, by Mr. Pickering, that the valency of an atom is never a whole number, but slightly smaller or larger, Dr. Armstrong remarked that it was impossible at present to put any such hypothesis to the test, owing to the complexity of the phenomena which had to be interpreted. On the other hand, the hypothesis to which attention had been directed by Helmholtz, in the last Faraday lecture, involved a precise and clear conception —that of a definite unit-valency—and was a necessary deduction from Faraday's law of electrolysis: in the speaker's opinion there was as yet no other course open than to consider the facts in the light of this hypothesis. He was, however, entirely of Mr. Pickering's opinion with regard to the interpretation to be given of the thermal values obtained on neutralising dilute solutions, having already, in fact, as Mr. Pickering had pointed out in his paper, used the same argument in reply to Dr. Nicol in the course of the discussion on the nature of solution at the meeting of the British Association at Birmingham. Dr. Nicol did not appear to have recognised its force, to judge from the remarks at the conclusion of his paper in the current part of the *Transactions*; and disregarding the evidence afforded by the heat-evolution on dissolution of many salts—which can only be due to one cause, viz., to association of the dissolved substance with water—claims, in support of his contention, that hydrates do not exist in solution, the results of the thermal study of changes which it is almost beyond doubt are of a complex character, and which have hitherto remained uninterpreted.

50. "*The Action of Metallic Alkylates on Mixtures of Ethereal Salts and Alcohols.*" By T. Purdie, Ph.D., B.Sc., Professor of Chemistry in the University of St. Andrews.

The author having observed (*Trans.*, 1885, 855) that the ethylic salts of fumaric, cinnamic, and oxalic acids are converted into the corresponding methylic salts by the action of a solution of sodic methylate in methylic alcohol, finds that the reaction in question is of general application: that is to say, when a mixture of an alcohol with an ethereal salt containing a different alcoholic radicle from that of the alcohol, is treated with small quantities of sodic or potassic alkylate, an interchange of radicle takes place between the alcohol and the ethereal salt; and that the chemical change exhibits in a marked degree the character of continuous action. It is supposed that the reaction is effected by the continuous formation and decomposition of a compound of the ethereal salt with the alkylate.

Besides the cases mentioned above, a similar reaction is found to occur when minute quantities of alkylate are added to the following mixtures: methylic oxalate with ethylic alcohol; amylic oxalate with ethylic or methylic alcohol; and ethylic oxalate with amylic alcohol.

Also in the case of mixtures of amylic acetate with ethylic or methylic alcohol; ethylic acetate with amylic alcohol; and phenylic acetate with ethylic alcohol.

A series of blank experiments to which no alkylate was added was performed for purpose of comparison. While the extent of interchange of alcoholic radicle occurring in the latter is usually small, the interchange in the former amounts, under similar conditions, frequently to 50 per cent, and in some instances is almost quantitatively complete.

Discussion.

Dr. Armstrong remarked that, as Prof. Purdie had not failed to point out, the exchange of radicle occurring between the ethereal salt and the alcohol is most probably effected by the alternate production and decomposition of an additive compound formed by the union of the salt with the alkylate, in the manner suggested by him in a "Note on the Action of Sodic Ethylate on Ethylic Oxalate and other Ethereal Salts," communicated to the Society in January, 1874 (*Ber.*, vii., 129). Several applications of the principle involved in this explanation were to be found in the edition of vol. iii. of "Miller's Chemistry," by Mr. Groves and himself (at pp. 861, 907, 923), and the formation of ethylic acetoacetate from ethylic acetate and sodium ethylate was there represented (p. 909) by equations identical with those recently put forward as original by Claisen and Lowman; whose experiments throw as much, but no more, light on the genesis of the aceto-acetate as Geuther's original experiments—a fresh proof that these last are still not rated at their proper value. It was remarkable, also, that it was not generally recognised that sodium ethylate, not sodium, was the effective agent in transforming ethylic salts, W. Wislicenus having, for example, in his recent paper, represented the change effected by sodium in mixtures of ethylic salts as directly due to the sodium, and as involving the formation of sodium substitution-derivatives. The additive compound of the sodium alkylate with the ethereal salt had been represented by himself and others as an atomic compound, the assumption being made that the elements of the alkylate became distributed; it might be pointed out that it was, perhaps, unnecessary to make this assumption, it being conceivable that change would supervene if once the alkylate became associated with the ethereal salt without its elements becoming distributed.

Research Fund.

A meeting of the Research Fund Committee will be held in June. Fellows desiring grants are requested to make application before June 11th.

NOTICES OF BOOKS

Handels-Bericht, von Gehe und Co., in Dresden. (Commercial Report, by Gehe and Co., of Dresden). April, 1887.

This pamphlet contains, as usual, a notice of the present state of the market for drugs and chemicals, accompanied by forecasts of probable fluctuations in value. In the introductory pages we notice the following significant remark:—"The war of all against all which in politics is as yet only threatened is, in the commercial sphere, now for years becoming a more and more striking fact."

The first portion of the work is devoted mainly to pharmaceutical preparations. The classification, however, is by no means very exact. Thus we find, in this section, metallic aluminium, sulphate of ammonia, chloride of lime, salts of strontia, tannin, &c., all of which are used much more extensively in the arts and manufactures than in medicine, and would, we submit, find a more suitable place in the second part of the work. The nomenclature adopted here is also peculiar, and we think objectionable. Chemical compounds are designated not by the names given to them in chemical text-books but by the peculiar Latin epithets applied to them by German physicians and pharmacists. Some of these names are apt to mislead. Thus potassium chlorate figures here as "kalium chloricum," whilst potassium chloride is styled "kalium chloratum."

In the section treating of "chemico-technical products and dye-wares" we find repeated mention of the conventions entered into among manufacturers in various countries to maintain or improve prices by a restriction of production. Thus chloride of lime—or, as it is here called, "calcium hypochlorosum"—has been raised in price from £6 per ton to £8, by an agreement among the chief English producers.

Under many articles, however, we still find complaints of unremunerative prices. Thus alizarine is now in such a state of depression that its manufacture is no longer profitable. Of the aniline colours it is also said that their prices, which previously yielded only a minimum gain to the makers, have fallen still lower during the past six months. It is a suggestive fact that, in view of the low figures offered for the by-products of the gas-manufacture, new methods of utilising the tar are eagerly sought for, and some managers of works are again burning it under the retorts to economise coke.

Artificial indigo is no longer mentioned, but the writers hope that some of the 103 species of indigo-plant found native in Africa may be successfully cultivated in the possessions recently acquired by Germany in Africa, so as to compete with the supply from India. Due note of this threatened competition should be taken by our planters, who may assuredly succeed in improving both the quality and the yield of their produce.

The consumption of the extracts of dye-woods appears to be still increasing, notwithstanding the coal-tar colours.

The cultivation of annatto, formerly restricted to Cayenne, Guadeloupe, and Brazil, seems to have been lately extended to Java and Cochin China.

Cochineal is likely to become still cheaper, since its cultivation, or rather collection, has been taken up in the La Plata territories, where both the insect and its food-plant are abundant, especially in the provinces Cordoba, Mendoza, Santiago, del Estero, and Rioja. In Tucuman it is sold as a paste, in the form of small dry cakes, under the name "grana."

There was a time when the production of cochineal might have been undertaken in Australia, where the cactus is becoming rampant; but at present prices it is out of the question.

The importation of strontium salts into Germany, chiefly from Britain, has increased in spite of the protective duty of 2s. per 100 kilos. It has risen from 5810 metric cwts. in 1885 to 11,534 in 1886.

Under "soda-saltpetre," which is oddly placed among the pharmaceutical products, a rise of prices is pointed out as probable. The stocks in the principal parts of Europe and America have fallen from 460,000 tons in 1884 to 168,000 tons last year; consequently the convention of the South American producers will find an increase of prices perfectly practicable.

The production of sulphate of ammonia, the chief rival of Chili saltpetre as far as agriculture is concerned, seems to have been steadily increasing in the United Kingdom. The yield in 1883 was 75,000 tons, whilst last year it reached 103,000 tons, all of which except about 20,000 tons was exported.

Carbon disulphide, here called "alcohol sulphuris," is protected in Germany by an import duty of 3s. per 100 kilos.

Mention is made of three aluminium bronzes made in Berlin. No. 1, of a golden yellow colour, is composed of 10 parts aluminium and 90 copper. No. 2 resembles a 14-carat gold, and contains 5 parts aluminium and 95 copper; whilst No. 3, which resembles red copper, is a mixture of 2½ per cent aluminium with copper and silicon. All are readily fusible, resist the action of the air, bear polishing, and can be rolled out as thin as it may be required. No. 3 can be used for telegraph-wires in place of silicon bronze.

As a solder for joining aluminium we find recommended an alloy of 5 parts zinc, 2 parts tin, and 1 part lead, melted together and rolled out into thin sheets. The surfaces of aluminium to be soldered must be scraped clean, and then covered with paraffin to prevent oxidation, which would otherwise prevent adhesion.

Many passages in this useful report confirm the utterance of an eminent German paper, that commercial competition is now war to the knife.

The Phoma-Disease in Vines occasioned by the Parasitic Fungi Phoma vitis *and* Phoma Cookei. By Felix von Thümen. (Die Phoma-Krankheit der Wienreben verursacht durch die parasitischen Pibze *Phoma vitis* und *Phoma Cookei.*)

It would almost seem that the more useful and agreeable any plant is to man, the more it is attacked by enemies, animal or vegetable, so that he has a hard—and not always a successful—fight to save even a share of the produce for his own use. Thus wheat has its mildew, its smut, its canker, besides such animal foes as the wire-worm, the corn-weevil, the corn-moth, and the Hessian fly, which has really "landed in force" in these realms; the potato has its dreaded *Pteronospora* and its Colorado beetle; whilst the coffee plantations are ravaged by *Hemileia vastatrix*. But above all other cultivated plants the vine is a victim. In addition to the *Phylloxera*, we learn from the present treatise that it is liable to the attacks of about 350 parasitic fungi!

Among these enemies the two species of *Phoma* named in the title play by no means the smallest part, and they appear at present to be occasioning considerable damage in the vineyards of Austria and Hungary. This has led to their careful examination in the laboratories of the "Imperial Chemico-Physiological Experimental Station for the Vineyards and Orchards," at Klosterneuberg, near Vienna.

Fortunately in this case a means—simple and cheap in the extreme—has been found for overcoming the pest. The stems and branches of the vines are brushed over during the winter season with a 10 per cent solution of ferrous sulphate. This agent destroys the spores both of the *Phoma* and of *Gleosporium ampelophagum*, another enemy of the vine.

Notes on the Literature of Explosives. By Ch. E. Munroe. No. XII. 1886.

The theory of explosions is the subject of the principal note in this pamphlet. Since Mr. Threlfall published the results of his investigations in 1866, several scientists have worked on the subject, and although much light has been thrown on the matter by Sir F. Abel, Berthelot, and others, still the explanations offered by the last-named experimenter (*Proc. Nav. Inst.*, x., 206, 1884) did not seem satisfactory to Mr. Threlfall. With a view to deciding some of these points he has begun by examining cases where the explosion could be seen and watched. In order to effect this, small glass bulbs filled with mercuric fulminate were exploded in a tank of water provided with glass windows in the sides. Various experiments were tried and the effects noted by this means; and they are summed up in the conclusions—that the shock of an explosion must be transmitted either by the actual bodily motion of the products of explosion through the surrounding medium, which is thereby set in motion; by an undulatory motion; or by vortex rings. Gunpowder and other slow explosives act principally in the first two manners; but the examination of the conditions of the explosion of fulminates, gun-cotton, and others of a similar violent character, points to the strong probability of the formation of vortex rings as a means of transmitting the shock.

The second point considered in this paper is the action of detonators. Sir F. Abel's experiments in this direction, and the theory he suggested with regard to detonation,—that there might be some synchronism between the vibrations caused in air or ether by the influence of fulminate of mercury, and the natural period of vibration of a gun-cotton molecule,—are fully discussed and commented upon, and reasons are given for the non-acceptance of this theory and the adoption of that of vortex rings.

A short note follows on the two new explosives recently adopted by French and German artillerists, viz., *hellhofite* and *melinite*, both of which produce the most terrific effects when exploded in the neighbourhood of earthworks or masonry. Large sums of money have been expended by the French Government in manufacturing a stock of these shells, but unfortunately for them it has been only recently discovered that *melinite* slowly decomposes on keeping, so it appears probable that the money expended in its production is utterly lost.

Several notes follow on the explosion of Flood Rock, the manufacture of rackarock, the decomposition of potassium chlorate by heat, and others, all of which have already been noticed in the Chemical News.

Annual Report of the Proceedings of the Sussex Association for the Improvement of Agriculture. By Thomas Jamieson, F.I.C. 1886.

In the spring of the year 1884 experiments on pasture land were commenced, the object of these experiments being to obtain "information useful in forming new permanent pasture and in improving old pasture." For this purpose two sites were fixed upon, one having been in permanent pasture from time immemorial, and situated on the Sussex formation known as the "Hastings Beds." The other represented the great clay formation known as the "Weald," was practically undrained, and had never been cultivated.

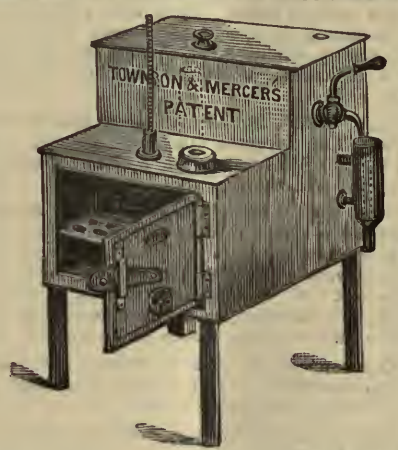
For the first two years the weather was so abnormally bad that probably most of the seeds were killed; but things have since improved, and the results for 1886 realised the anticipations that were formed. For cleaning old pasture four different methods were tried. The defect in many pastures lying in the abundance of weeds they contain, it was necessary to find whether the weeds could be removed by means of a harrow without hurting the grasses: this treatment alone did but little good, but when accompanied by seed and manure the produce was increased by 50 per cent, but the proportion of weeds did not diminish. When, however, the land was lightly ploughed, and then treated as above, the crop was increased by nearly 90 per cent and the quantity of weeds diminished.

Experiments on drainage were made, but the results do not seem to be at all clear, and that it would be premature to draw any inference is shown by the following statement:—"The crops of 1885 appeared even to be lessened by drainage: this may have been due to the drains drying what was already too dry, or to the injury done to the surface soil in process of forming the drains."

The application of *lime* to pasture land has also received some attention, and the results are entirely *against* the practice of using lime. This conclusion is rather astonishing in view of the very general idea that limeing is always advantageous, but it only emphasizes what we have on previous occasions insisted upon—that haphazard chemical manuring is practically worthless, and as likely to do harm as good. Sussex soil evidently does not need the addition of lime, though in other soils it is undoubtedly necessary.

The greater part of this report is occupied with experiments on grasses, the same as those conducted at Glasterberry, in the North of Scotland, and the results obtained at both stations generally agree.

Hot Water Oven with Cistern.—Considerable inconvenience is frequently experienced when chemical operations have to be carried on for several hours, necessitating constant attention to keep up the water supply. This difficulty has been effectually overcome by a water oven recently patented by Townson and Mercer, and shown in the accompanying cut, by which arrangement a constant supply of hot water is kept up without lowering the temperature of the oven. The supply cistern, with



a loosely fitting cover, is placed on the top of the oven, into which a tube passes from the oven, which acts partially as a condenser, also to heat the water. The cistern is supplied with a stop-cock from which the heated water drops into the water-level below, and can be so regulated as to just keep up the supply caused by evaporation without any overflow; an automatic supply arrangement is thereby produced for sixteen hours or more, it being simply a question of the size of the supply cistern.

Reagent for Sulphuretted Hydrogen.—O. Curtmann.—The author uses an aqueous solution of chloral hydrate mixed with a little ammonia. This reagent gives, even with very small quantities of hydrogen sulphide, a brown colouration on longer standing, the liquid becomes turbid and deposits a brown precipitate. Inversely, a mixture of solution of chloralhydrate and freshly-prepared sulphuretted hydrogen water is a reagent for ammonia.—*Zeitschrift für Analytische Chemie.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 4.

A Gas-burner for the Production of Monochromatic Light.—Noack.—The gas to feed the flame is charged with metallic salts by passing it through a flask in which hydrogen is evolved from zinc and a solution of the metallic salt in question.

Heating-Apparatus for Determinations of Melting-Points.— G. Olberg.— The apparatus consists of two vertical glass tubes of the form of test-tubes, connected below by two horizontal tubes melted in. The lower and narrower (1 c.m. in width) horizontal tube is let into the wider vertical tube (3½ c.m. in width and 15 c.m. in height) a little above its bottom, whilst its connection with the narrower vertical tube (2½ c.m. wide and 14 c.m. high) forms its lower end. The upper horizontal tube is wider (2 c.m.), and is fixed into both perpendicular tubes a little below the upper edge. Into the narrower vertical tube the thermometer and the melting-point tube are introduced by means of a cork with two perforations, so that the specimen and the bulb of the thermometer reach nearly down to its bottom. The entire apparatus is filled with a suitable heating tube (oil or the like) so far that the upper connecting tube is about half full, and the wider vertical tube is then gradually heated with a lamp. A circulation is thus produced in the oil in such a manner that it flows from the wider into the narrower vertical tube and returns below. Thus it is effected that in the tube containing the specimen, warmer and warmer strata are constantly sinking down without stirring, and a very gradual elevation of temperature is effected without stirring.

Boiling Tube for Fractional Distillations. — R. Hempel.—The inventor combines the two systems of Hempel and Winssinger (see *Zeitschrift Anal. Chemie*, xx., p. 502; and xxiii., p. 199).

Certain Useful Pieces of Laboratory Apparatus.—H. Landolt.—These include a combination of a water-bath with a hot water funnel; (2) an apparatus for concentrating very dilute liquids; (3) and a contrivance for sublimation. F. W. Dafert describes, in the *Chemiker Zeitung*, two dialysers and an arrangement to obviate the danger of fire when gas flames strike back.

A Convenient Double Aspirator.—A. Gawalowski.—The construction of this apparatus cannot be shown without the accompanying illustration.

A New Drop Funnel.—J. Walter.—From the *Journal für Prakt. Chemie.*

Improvements in Burettes and other Apparatus for Titration.—A great variety of devices which cannot be here described.

Applicability of Liquid Paraffin as a Reagent.—L. Crismer.—This substance dissolves in all proportions in alcohol and ether, if perfectly anhydrous, forming a clear liquid which is rendered turbid by the smallest quantity of water or aqueous alcohol. Absolute alcohol takes up only a certain quantity of paraffin oil, and if brought in contact with a larger quantity of paraffin, two clear liquids separate out, pure paraffin oil and a saturated solution of it in the alcohol. If a small quantity of aqueous alcohol is brought in contact with the latter, an immediate turbidity is produced. If 20 c.c. of chloroform or absolute alcohol are mixed with 0·04 c.c. of a 50 per cent alcohol, and a few drops of paraffin oil are added, a distinct turbidity appears. The author finds, further, that paraffin oil freely dissolves chlorine, iodine, and bromine, as well as colourless phosphorus and its halogen compounds, and those of the alcohol radicles.

Solid Sulphuric Acid.—Infusorial earth takes up 3 to 4 parts of sulphuric acid, forming a dry powder which is very serviceable in the exsiccator.

Method for the Volumetric Determination of Potassa. — Dubernard. — From the *Journal of the Chemical Society.*

Calorimetric Determinations of Small Quantities of Manganese.—M. Osmond.—From the *Bulletin de la Société Chimique de Paris.*

Application of Neutral Potassium Chromate.—L. Crismer.—One mol. potassium chromate, 193·96, must liberate 3 atoms iodine, 379·59; consequently, 1 c.c. of the centinormal solution of potassium chromate represents 0·0037959 iodine. Hydrochloric acid sometimes contains traces of chlorine or ferric chloride, which in presence of potassium iodide liberate iodine. Hence the author uses dilute sulphuric acid. If in this reaction a decinormal solution of potassium chromate is used, and the iodine liberated is titrated with sodium hyposulphite in presence of starch, it is very difficult to fix on the end of the reaction. But with the centinormal solution the procees is easy. 20 c.c. of a 10 per cent solution of potassium iodide are acidified with 10 c.c. dilute sulphuric acid (1 : 4) and 20 c.c. centinormal solution of potassium chromate are added. The solution of hyposulphite is then dropped into the iodine solution until the red colour is changed into a clear greenish yellow, 1 c.c. of fresh-prepared starch solution is added, and the operation is completed as usual.

Method for the Volumetric Determination of Potassium Iodide.—E. Fallieres.—From the *Journal de Pharm. et Chimie.*

New Method for the Determination of Sulphur.—N. von Kloblulow.—This paper will be inserted in full as early as possible.

New Method of Determining Sulphur in Pyrites.—J. Clark.—From the *Journal Soc. Chem. Industry.*

Volumetric Determination of Sulphuric Acid.—H. Wilsing.—If the liquid to be titrated is acid, and if it contains no compounds precipitable by soda from 20 to 50 c.c. of the solution are mixed, boiling in a porcelain capsule with an excess of a 4 per cent solution of barium chloride (the value of which is previously determined gravimetrically), a few drops of an alcoholic solution of phenol-phthalein (1 : 30) are added, and the boiling liquid is titrated with a 2 per cent solution of soda to incipient reddening. If the solution is acid, phenol-phthalein is added to the boiling liquid, and soda solution is added until reddening sets in. The same procedure is used in presence of compounds precipitable by soda. If the solution is alkaline, it is first neutralised with hydrochloric acid.

Method for Determining Phosphorus in Crude Iron and Steel.—W. Kallmann.—The author weighs into a platinum crucible from 1 to 10 grms. of the sample, mixes with it from 1 to 2 parts of a mixture of 2 parts calcined magnesia and 1 part potassium sodium carbonate, and ignites over a Bunsen burner for an hour, first in a closed crucible and then in an open one, placed slanting, stirring every ten minutes with a platinum spatula. When cold the pulverulent mass is removed from the crucible into a beaker, and extracted with citric acid with the aid of heat. using so much that the liquid, after warming, has an acid reaction. It is now filtered and washed, first by decantation, and then on the filter with a 1 per cent solution of citric acid, until a specimen of the filtrate no longer occasions, with ammonium chloride and ammonia, a turbidity on standing. The very first portion of the filtrate generally passes through the filter, and must therefore be poured back. The precipitate is easily washed. The filtrate is mixed with ammonium chloride solution to which

one fourth volume of strong ammonia is added, stirring for some time with the glass rod, when the precipitate of ammonium-magnesium phosphate is deposited. It is then allowed to stand until the settlement is complete, when the clear liquid is carefully poured away from the precipitate through a filtrate. The precipitate is dissolved in hydrochloric acid and re-precipitated with ammonia. The double phosphate falls in coarse crystals, and can be filtered off in from half an hour to an hour. The precipitate is then further treated in the ordinary manner and weighed as magnesium pyrophosphate.

Determination of Phosphorus in Iron.—J. B. Mackintosh.—From the *Trans. of American Institute of Mining Engineers.*

Colorimetric Method for the Rapid Determination of Traces of Nitric Acid in Air, Water, &c.—A. Grandval and H. Lajoux.—From the *Comptes Rendus.*

A Reaction of Chloral Hydrate.—Hirschfeld.—If to a solution of chloral hydrate there is added some calcium hydrosulphate, there appears in half a minute a red colour, which finally becomes purple red. A reaction which is fainter, but still distinct, is obtained by adding to a solution of sulphuretted hydrogen, and then lime-water.

Reactions of Alkaloids.—A. Luchini.—A table, showing in parallel columns the reactions of the commonest alkaloids with Wenzell's reagent and the author's. The former is a solution of permanganate in 200 parts sulphuric acid, and the latter a solution, prepared hot, of potassium chromate in sulphuric acid. Luchini considers that these reactions together render the other so-called general reactions for alkaloids superfluous.

Novel Reaction for Digitaline.—Ph. Lafon.—From the *Comptes Rendus.*

Characteristic Reaction of Codeine.—Ph. Lafon.—From the *Comptes Rendus.*

The Properties of Sparteine.—A. Houdé.—From the *Journal de Pharm. et Chimie.*

Determination of Carbon and Hydrogen.—E. Lippmann and F. Fleisner.—A modification of Kopfer's process, copper oxide asbestos being used instead of platinised asbestos.

Determination of Nitrogen in Organic Bodies.—A. von Asbóth finds that the Kjeldahl process may be modified as to be available for the determination of nitrogen in all nitrogenous bodies (including the nitrates) save the pyridin and chinolin group. For substances which, under the ordinary treatment, yield all their nitrogen in the form of ammonia, and which do not give off free nitric acid on treatment with sulphuric acid, the author adds two parts pure cane-sugar to one of the substance. In nitrates and mixtures of such with other nitrogenous matters, the total nitrogen is obtained in the form of ammonia by adding to the substance benzoic acid, 1·7 benzoic acid to 0·5 potassium nitrate being the most suitable proportion.

Valuation of Crude Calcium Acetate.—Harcourt Phillips.—From the Chemical News.

Novel Method of Determining Glycerin.—W. Fox and J. A. Wanklyn.—From the Chemical News.

Salicylic Acid in Beer.—Röse.—The author puts 100 or 50 c.c. in a roomy separating funnel after acidifying with 5 c.c. dilute sulphuric acid, and adds an equal volume of a mixture of equal parts of ether and petroleum ether. He then shakes up the mixture well and distils the filtered ethereal layer into a flask to within a few centimetres. Into the flask, while still hot, there are put 3 to 4 c.c. of water; it is agitated, a few drops of a dilute solution of ferric chloride are added, shaking gently, and the liquid is then filtered through a moist paper. If salicylic acid is absent the filtrate is clear as water, with a faint yellowish tint; if present, the filtrate has the well-known violet colour.

The Ash of Ceylonese Cinnamon.—A. Hilger.—In five samples, grown on different soils, the ash was respectively 4·5, 4·8, 3·9, 4·3, and 3·4 per cent; the proportion of soluble matter in the ash ranged from 53 to 88 per cent.

Analysis of Iron.—J. Peter.—From the *Bulletin Soc. Chimique.*

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 5, March 5, 1887.

Preparation, Properties, and Constitution of Inosite.—M. Maquenne.—Inosite melts, without decomposition, at 217°, and boils at 319° in a vacuum. At the ordinary pressure it becomes carbonised before boiling. It is sparingly soluble in cold water, but very soluble in hot water, and insoluble in alcohol and ether. It dissolves readily in hot dilute acetic acid. It is found to possess no rotatory power. Its resistance to hydrogenation, its want of reductive properties, and its non-production of acids on oxidation, prove that it is not an aldehyd. As it does not combine with sodium disulphite, and as it cannot be split up into fatty acids less rich in carbon, it cannot be an acetone. It must, therefore, be a secondary alcohol, an hexa-oxybenzene hexa-hydride.

Preparation of a Calcium Silico-stannate corresponding to Sphene.—L. Bourgeois.—The author has obtained this compound as a brilliant white crystalline powder, the particles of which, under the microscope, appear as klino-rhombic prisms.

Determination of Certain Elevated Points of Fusion and Decomposition.—H. Le Chatelier.—The author gives his results in the form of tables. The figures which he gives for the fusion-points of the alkaline salts, excepting those of barium, strontium, and calcium chloride, agree well with the determinations of Prof. Carnelley.

On Kirsch.—X. Rocques.—Four of the twenty samples examined by the author were genuine kirsch mixed with the inferior brandy known by French spirit merchants as "trois-six," and fourteen were rice-spirit slightly scented with essence of bitter almonds.

Certain Lecture Experiments.—A. Mermet.—The author, preparing hypochlorous anhydride by the usual process used, as a refrigerant, liquid methyl chloride instead of a mixture of snow and salt. A violent explosion took place, the apparatus being destroyed and the assistant in charge having the lobe of his right ear torn. This catastrophe is ascribed to the vapours of two liquids coming in contact.

Two New Colouring-Matters for Wine.—A. J. Ferreira da Silva.—Already noticed.

M. Weil's Process for the Volumetric Determination of Grey Zinc Powder.—Prof. Kupferschlæger.—The author, after briefly describing Weil's process, remarks that zinc powder often contains iron and cadmium which would reduce cupric chloride, as well as does zinc. The author proposes to treat the zinc with sulphuric acid largely diluted with boiling water, to treat this solution with ammonium carbonate, and then to filter. The clear liquid may then be titrated with a normal solution of sodium sulphide. Prof. Kupferschlæger admits that this method determines not merely the metallic zinc present, but also the zinc oxide.

Agricultural Value of Reverted Phosphate.—Jules Joffre.—The author maintains that the reverted phosphate is an iron phosphate, and not a bicalcic phosphate. Its agricultural value appears to differ little from that of ground insoluble phosphate, and is decidedly inferior to that of the soluble phosphate.

Action of Hydrochloric Acid upon the Solubility of the Chlorides.—R. Engel.—Already noticed.

Solubility of Magnesium and Calcium Chlorides at 0°.—R. Engel.—Already noticed.

MEETINGS FOR THE WEEK.

Tuesday, 31st.—Royal Institution, 3. "The Modern Physiology of the Brain, and its Relation to the Mind," by Prof. Victor Horsley, F.R.S.
Thursday, June 2nd.—Royal Institution, 3. "The Chemistry of the Organic World," by Prof. Dewar, F.R.S.
—— Chemical, 8. Ballot for the Election of Fellows.
Friday, 3rd.—Royal Institution, 9. "The Application of Photography to Astronomy," by David Gill, LL.D., F.R.S.
Saturday, 4th.—Royal Institution, 3. "Victorian Literature," by Prof. John W. Hales, M.A.

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ON THE

SUPPOSED "NEW FORCE" OF M. J. THORE.*

By WILLIAM CROOKES, F.R.S., Pres. C.S.†

The author commences by quoting the description of some apparatus and experiments which have led M. Thore to suspect the existence of a new force inherent in the human organism. M. Thore suspends a small cylinder of ivory by a fibre of cocoon silk, forming a small pendulum, which hangs freely over the centre of a table. The cylinder having become motionless, M. Thore brings a second cylinder, called the "pillar," about a millimetre from the first cylinder, when the latter begins to rotate clockwise if the pillar is on the left, and counter clockwise if the pillar is on the right of the cylinder. The observer is supposed to face the cylinder and pillar. M. Thore says that the rotation is independent of the nature of the cylinders, of their mass, or the dimensions of the pillar; light, heat, electricity, magnetism, gravity, and air currents, he says, are also inadequate to explain the phenomena.

The author has repeated M. Thore's experiments in apparatus shown in the accompanying figure. It consists

of a glass case, A, B, C, D, E, F, six and a half inches square and seven inches high, with a rising glass window, A, B, G, H, in front and similar windows at the sides. The top is of card, in the centre of which is a small hole. The cylinder, I, is suspended in the middle of the case by a very fine cocoon silk fibre, 5 feet long, surrounded by a card tube, J, attached to the top of the glass box. K is a second cylinder attached to a support, L, M, by a ball and socket joint for convenience of adjustment. The support, M, projects outside the case to admit of the *pillar* being brought close to the *cylinder* and transposed from one side to the other, &c. N is a cord attached to the front glass window, weighted at the end and passing over a pulley for convenience of raising and lowering the glass.

Ivory, ebonite, glass, and metal have been used for the cylinders and for the pillars. The pillars have also been made square, round, and wedge-shaped in section, and the surfaces have been bright and lamp-blacked. The mode of experimentation is the following: — The cylinder being at rest, the observer sits down in front of the apparatus with his face 8 inches from the cylinder and pillar, taking precautions to keep the breath as much as possible away from cylinder and pillar. The pillar is always placed on the right of the cylinder. On raising the front glass the cylinder commences to rotate in the opposite direction to the hands of a clock, the side nearest the observer moving to the right.*

In other experiments a flask of boiling water, a candle, and a hot platinum wire have been used as the source of radiation. The results of more than 50 experiments are given in tables, showing the material of the pillar, the maximum speed of one revolution, the number of revolutions, and the exciting agent. Experiments tried with an ascending current of air of different degrees of intensity in front of the apparatus, prove that air currents are inoperative in producing the action.

The results leave little doubt that the action is one of radiation from the face or other warm body in front of the apparatus, and that there is nothing special in the human organism beyond the heat it radiates to produce rotation of the cylinder.

Radiant heat (and in less degree light) falling on the lampblacked surfaces is absorbed, and increases the surface temperature. There are two ways in which this increase of temperature may act:—

1. It may produce a current of warm air, rising in front of the surfaces of the moving body; to replace this, cold air will come in from all sides, and striking against the delicately suspended cylinder cause it to rotate. If, however, the source of heat is of considerable surface, such as the face or a Winchester quart bottle full of warm water, it is difficult to imagine that there will be much tendency to rotate in one direction rather than in the other.

2. An increased surface temperature of the cylinder and pillar may produce an increase of molecular pressure between the two bodies, and thus give rise to motion, after the manner of the radiometer. In this, as in the former case, the movement should be in the opposite direction to what it is in reality, as it would be produced by mutual repulsion acting between the sides nearest the source of heat.

It seemed likely that information, decisive as regards one or other of these two theories, might be gained by suspending the cylinder in a glass tube attached to a Sprengel pump, and taking observations at different degrees of exhaustion.

In experiments tried by the author in 1875† the noteworthy fact was ascertained, that two bodies of different temperature attracted each other at normal atmospheric pressure; the attraction rose as the pressure diminished, until, at a tension of 1·15 millims., it was nearly four times what it was in dense air. Above this exhaustion the attraction suddenly dropped and changed to repulsion, which at the best vacuum obtained was nearly thirteen times stronger than the attraction in air.

* "Une Nouvelle Force?" Par J. Thore. Dax, 1887.
† Abstract of a Paper read before the Royal Society, May 26, 1887.

* This is called the *negative* direction, and when the rotation is clockwise it is called *positive*.
† *Phil. Trans.*, 1875, Part 2 (pp. 528 to 532).

Two forms of apparatus are described by the author, wherewith experiments were tried during exhaustion, and an exact parallelism was established between the attraction or repulsion of the cylinder by a hot platinum spiral, and the positive or negative rotations of the cylinder under the influence of a warm body brought near.

The two phenomena run absolutely in parallel lines; when there is attraction negative rotation is also produced; when the exhaustion is such that the attraction is *nil*, the rotation is *nil* also; when the attraction changes to repulsion the rotation changes from negative to positive; and when the vacuum is very good, so that the repulsion between the two heated bodies is at its maximum, then also the positive rotation is the strongest. It is impossible to resist the conclusion that the two sets of phenomena are due to the same cause, and that as air currents did not produce the attractions observed in the 1875 experiments, so likewise are they equally inoperative in giving rise to the present rotations of the suspended cylinder.

If the rotation is produced by a reaction between the suspended and fixed body, it follows that were both free to move each would rotate, but in opposite directions. To test this, another apparatus was made, having two delicately suspended cylinders, one millimetre apart, in a glass tube capable of being exhausted. In a table the results of 22 experiments are described, observations having been taken at intervals during exhaustion. Down to 14 millims. pressure the two cylinders rotate negatively (*i.e.*, the right hand cylinder rotates clockwise, and the left hand cylinder counter clockwise). Between 14 and 3 millims. there is no rotation, and below 3 millims. the rotation is positive, the movement at an exhaustion of 0·0495 millim. being five times as strong as it was originally.

The motive force producing these rotations is, at high exhaustions, the molecular impacts between adjacent surfaces of the suspended cylinders excited by the radiation falling on them from the hot water, hot spiral, or a candle (which is equally effective). But what produces the negative rotation at ordinary atmospheric pressure? *Air currents* are the obvious explanation, but there are grave reasons for believing this explanation inadequate. In the first place actual air currents when tried do not produce the desired result. Secondly, it is most logical to assume that as the present set of experiments are strictly parallel with those tried in 1875, and as in each case the results at high exhaustions are due to molecular bombardment, so also must the similar results at low exhaustions be due to the same cause.

Finally, 21 experiments in the form of a table are described, in which an apparatus was employed, specially designed to eliminate the interfering action of air currents, and submit the molecular bombardment theory to crucial experiments. The results are considered by the author as conclusive in favour of this explanation.

Addendum, May 24, 1887.

I sent M. Thore a detailed account of my experiments, asking him to favour me with any comments or remarks he might wish to make. I have just received a long communication, partly printed and part in MS., in which he describes many fresh experiments, and adduces arguments to show that my dynamical explanation is not sufficient to account for more than a few of the facts he describes, and saying that he "persists in still believing that this force emanates from the observer, or else that the observer is the indispensable intermediary for its manifestation."

The experiments are numerous and are devised with great ingenuity. It is impossible in the space of a brief abstract to do more than refer to a few of the principal facts here brought forward. M. Thore commences by objecting to my having experimented in an enclosed space, saying that he always operates in free air. He thinks that enclosure may almost or quite suppress his force. To this I can reply that I myself verified nearly all M. Thore's facts of rotation (including those just now communicated), when working in the free air of a large room, and it was only when I found the delicacy of the observations was impeded by draughts and currents that I put screens round the apparatus. I have not found glass screens interfere materially with any of the rotations. M. Thore now says that it is necessary to hold the pillar or the exciting body in contact with the hand during the whole duration of the experiment. I was not aware that importance was attached to this point, but I have since repeated many of my former observations, holding the pillar in the hand. The results are certainly stronger, but the extra heat imparted to the apparatus is in my opinion sufficient to account for this. M. Thore brings forward many new and ingeniously devised experiments to prove that heat cannot be considered the cause of the movement. He exposes the instrument to the full sun and then brings it into a cool dark room; he suspends it over boiling water; he places a large block of ice between the cylinder and the observer; he similarly interposes metallic vessels full of boiling water between the cylinder and observer (the observer not moving from his place in front), and he tries the experiment in a hot chamber alternately moist and dry, without finding the regularity of the movements interfered with. I have tried most of these, and obtained results corroborating M. Thore's, but I have also tried the experiment of quietly bringing near to the stationary cylinder a bottle of hot water and observing the movement from a safe distance through a telescope, and I find that the hot bottle is able to effect rotation as well as the observer.

Among the curious observations mentioned by M. Thore is this:—Placing the pillar in front of the cylinder (between it and the observer), if the pillar is held with the right hand the movement is clockwise, and if the left hand is used the rotation is counter-clockwise. The right hand is stronger in its effects than the left hand in the proportion of 1 to 2.

M. Thore has given in addition a large number of curious and interesting observations, using two, three, and more movable cylinders and recording their movements under a great variety of circumstances. I admit I do not see at once how all these are to be explained on the molecular bombardment theory. But this theory has not yet explained all the anomalous results I have recorded in my papers on "Repulsion resulting from Radiation," although I believe it capable of doing so; and I therefore think that it is not necessary to call upon a new force to explain any of M. Thore's results which radiation does not yet seem able to account for.

ON THE

DISSOCIATION OF SOME GASES BY THE ELECTRIC SPARK.*

By J. J. THOMSON, M.A., F.R.S.,
Fellow of Trinity College, and Cavendish Professor of Experimental Physics in the University of Cambridge.

The gases considered are iodine, bromine, chlorine, and nitrogen tetroxide. The effects of the spark on iodine and bromine were investigated in two ways. In the first method the iodine was placed in a tube from which the air had been exhausted, and which was furnished with a gauge which served to measure the changes of pressure in the tube. The liquid in the manometer was sulphuric acid, and in order to avoid any disturbance due to the absorption of the iodine vapour by this substance, the discharge tube was doubled so that the iodine vapour was symmetrically placed with reference to the sulphuric acid. The system was then placed in an oil-bath and maintained at a temperature which varied in different experiments from about 200° to 230°.

* Abstract of the Bakerian Lecture delivered before the Royal Society, May 26, 1887.

On sparking through such a tube with an induction coil giving a spark about 3 inches long in air, the pressure rapidly increased at first, but the rate of increase gradually diminished and the pressure finally becomes steady. On stopping the coil by far the greater part of this increase is permanent, or at any rate lasts for several hours. It is not due to the decomposition of the vapour from the sulphuric acid in the gauge, for it does not occur if there is no iodine in the gauge, or if the iodine is replaced by bromine. This increase of pressure can be produced by the silent discharge as well as by ordinary sparking. In order to test this point more completely, I had an arrangement made by which, instead of determining the increase of pressure by the sulphuric acid gauge, the vapour density of the iodine after sparking could be measured. In this arrangement the iodine was never near any sulphuric acid.

The result of these determinations is shown in the following table, and it is seen that the results confirm those obtained by the first method.

Unsparked iodine—

Pressure.	Temperature.	(H = 1). Vapour-density.
440	215	137
420	214	130
Sparked iodine—		
618	220	110
420	216	115
166	214	84
170	232	86

In the last experiment the vapour-density was determined twenty-four hours after the sparking.

These figures point to very considerable dissociation of the iodine; in fact the dissociation produced by the spark at 214° is as much as that produced by Victor Meyer at the temperature 1570° C.

The appearance of the dissociated iodine is not greatly different from that of the unsparked; its colour, however, is, I think, a little lighter and not so uniform. I was not able to detect any change in the absorption spectrum produced by the sparking. The electric strength of the sparked gas was, however, less than that of the unsparked.

Bromine.

When the experiment with the pressure gauge is made with bromine instead of iodine, it is found that there is a considerable increase of pressure produced by the passage of the spark, but that this disappears almost as soon as the sparking, and on determining the vapour-density of the sparked and unsparked bromine it is found that they are identical, it seems most probable that the difference between bromine and iodine is not that the bromine is not dissociated by the spark, but that the atoms combine very much more quickly than the iodine atoms. The vapour-density determinations showed that bromine vapour is dissociated if it is heated for a long time at a low pressure, even though the temperature is not very high.

The results of these determinations are given in the following table:—

Pressure.	Temperature.	Density.	Remarks.
473	111	80	
466	106	81	
430	101	80	
602	116	79	
543	89	81·7	In bath for 24 hours.
315·5	105	73	
235	109	77	*Sparked.*
230	100	66·5	In bath for 4 hours.
165	90	77	Only a short time in bath.
390	111	70	In bath for 7 hours.

These experiments show that it takes a long time for bromine to reach a state of equilibrium, and that for the experiments on the vapour-density, the gas should be kept for a long time at a constant temperature before the experiments are made.

Experiments on chlorine and nitrogen tetroxide are also described in the paper.

VITALISING AND DEVITALISING OXYGEN.

In the current number of *The Asclepiad* there is, amongst other valuable articles, a most interesting one by Dr. B. W. Richardson, F.R.S., on the vitalising and devitalising action of oxygen on different animals and under different conditions.

In turning back to the records of some of our earlier experimentalists we find very different opinions expressed as to the action of oxygen on the bodies of men and animals. One observer finds that it acts as an excitant, while another shows evidence to the effect that it is a narcotic and a depressant. Let it be well understood that in all cases ample precautions were taken to keep the chambers in which the animals under experiment were placed free from excess of carbonic acid, and analyses made from time to time proved that this was effected. In spite of these precautions Dr. Richardson suspected that some error had crept in, or that something had been overlooked in the experiments in which oxygen was shown to act as a narcotic. He therefore determined to carry out fresh inquiries in which there could be no possibility of any carbonic acid remaining in the chambers: this was effected by maintaining a continual flow of pure oxygen through the chambers, so as to keep them thoroughly ventilated, the temperature of the gas being kept constant at 60° F.

The results of these experiments showed that freshly-made pure oxygen acted in a different manner as a vitaliser on different animals. Some were apparently unaffected; others were rendered feverish; but in no case was narcotism produced, so long as the supply of oxygen was kept up. A second chamber was constructed large enough to be divided into compartments, so that all the animals could be kept in the same oxygen under exactly the same conditions; but the results found were identical with the former in every respect.

These observations, important as they are in confirming the results of one previous writer, contradict entirely those of another, who nevertheless conducted his inquiry with ample care, as will soon be shown, although he did not find the real causes which led to the results he found. These causes, like so many other important discoveries, were found in the most unexpected manner. With a view to examine his oxygen Dr. Richardson had two reservoirs constructed, one filled with pure oxygen and the other with pure water. After passing through the chamber in which the animals were placed, the gas was collected by displacement in the reservoir of water: in this manner none was lost, except that consumed by the animals. Before being used a second time it was completely dried, and purified from carbonic acid, ammonia, and all appreciable impurities.

During the first passage of this charge of oxygen the same phenomena were produced as in the previous experiments, but on being passed through the chamber a second time a most remarkable change occurred. The animals all became drowsy. The current was quickened, and the gas in the chamber tested, and found to be simply pure oxygen. Still the drowsiness continued. As the experiment proceeded, the drowsiness—which resembled sleep of the quietest character—increased, until at length the startling result was obtained that pure oxygen, after several inhalations, eventually produces death, although no chemical test will show any difference in its composition from that of the freshly-made gas.

The other experiments previously referred to, when examined with this new light thrown upon them, are found to be perfectly correct. The oxygen was certainly kept free from carbonic acid, but, owing to the chamber being closed and not having a draught of fresh oxygen continually circulating, it necessarily came to pass that after a few hours all the gas in the chamber had been inhaled over and over again, with the curious result of devitalising it just described.

The term *devitalising* does not, however, convey the idea of any known modification in the gas; that it is not chemical in the accepted meaning of the word we have the authority of Dr. Richardson for stating; that there is a change is evident, and we can only hope that chemists will take up the matter and endeavour to find whether this change can be detected by chemical means hitherto unknown.

After having devitalised oxygen, attempts to re-vitalise it were made, and it was found that this could be easily effected by electrically charging it from a set of brushes connected with the positive pole of a frictional machine.

After having discovered an effect, the next thing to do is to find out the cause, and in this instance the problem set is a difficult one. Dr. Richardson himself inclines to the opinion that, "during the contact of the oxygen with the blood or the tissues of the animal, some quality of the gas essential to its vitalising power is lost, so that the gas becomes negative in its action." This sounds more like re-stating the fact than finding the cause, and seems hardly sufficient when considered in conjunction with its properties of supporting life in cold-blooded animals, and also supporting flame as vigorously as ever.

However this may be decided we have several examples of the facts repeatedly occurring, such as what is called the clearing of the air by a thunderstorm, which is evidently a re-vitalising of the oyxgen by means of the electric discharge.

In these days, when we are constantly hearing of bodies having had some properties modified, although the chemical tests at our command are not subtle enough to distinguish any difference in composition, we fall back on a general and convenient explanation, and say the anomalies are caused by a re-arrangement of the molecules. How far will this explanation answer the question set by the facts we have recited? The molecules are all present —why will they support life in a cold blooded and not in a warm-blooded animal?

RESEARCHES ON THE LITHIA MICAS.*

By F. W. CLARKE.

I. The Lepidolities of Maine.

In the western part of Maine, along a line running southeasterly from the Rangeley Lakes to a point on the seaboard between Brunswick and Portland, there are a series of veins of albitic granite which are noted for their contents in lithia mica and coloured tourmalines. These localities, in the towns of Rumford, Paris, Norway, Hebron, and Auburn, are all within a narrow belt of about forty miles in length; and with them, as a probable part of the same system, may be classed the spodumene locality in the town of Peru. The northernmost of the known localities is that on Black Mountain in Rumford; but a few fragments of inferior green tourmaline have been found about five miles farther north, in Roxbury—a fact which indicates a prolongation of the belt in that direction. Similarly, a southern extension of the belt is suggested in the territory covered by the towns of Pownal, Yarmouth, and Freeport, a region from which a few casual specimens of lepidolite have been reported. The total width of the belt, so far as has been observed, appears to be not much over fifteen miles, although sharp definition of the area is not yet possible.

In general character the several localities are much alike, although in points of minor detail they vary considerably. With the tourmaline and lepidolite, quartz, muscovite, cleavelandite, cassiterite, and amblygonite are always found, together with a wide range of other species which cannot be considered here. Some of the differences are probably due to the fact that certain localities have been more thoroughly opened up than others, and these differences would probably be eliminated by more complete exploration. In other points, however, the variations are notable and characteristic. For convenience we may briefly consider the several localities separately, beginning with the northernmost and proceeding southward in regular order.

*Rumford.**—This locality, discovered in 1878 by Mr. E. M. Bailey, of Andover, Maine, is situated on the northern slope of Black Mountain, at an estimated elevation of about one thousand feet above the valley. The excavation, so far, has been merely superficial. A part of the lepidolite, which is very abundant, is fairly pure, lilac-purple in colour, and finely granular; but the larger portion of the mineral is coarser in structure and thickly sprinkled with small, opaque, red tourmalines. The colour of the latter is very rich and the appearance of the material carrying the associated minerals is strikingly characteristic. It resembles nothing from the other localities of the region. Green tourmaline occurs here but sparingly, while the spodumene is enormously developed, showing faces over a metre in length. At the other lepidolite localities spodumene is one of the scarcer minerals.

Paris.—The famous locality known as Mt. Mica has been so thoroughly studied by mineralogists that no detailed account of it is needed here. The lepidolite occurs both in the ordinary, purple, granular form and in broad foliations resembling muscovite. Analyses of it have been published by Berwerth and by Rammelsberg,† which agree fairly well with the results obtained in this laboratory.

Hebron.—The deposit at this point, about seven miles south-east of Mt. Mica, has long been well known to collectors. It has only been superficially opened, however, and deserves more systematic exploration. The lepidolite, which is coarsely granular and purple, is especially interesting on account of its yield in cæsia and rubidia, which, after their identification by Johnson and Allen here, were also found in the lepidolite of Rozena. As yet no complete analysis of the Hebron mineral seems to have been published. For the specimens examined in this laboratory I am indebted to the kindness of Professor G. J. Brush.

Associated with the Hebron lepidolite there have been found many specimens of red and green tourmaline, which, while preserving their crystalline form, have undergone an alteration into a softer mineral of an opaque, talcose appearance. Some of the material so derived from tourmaline has been supposed to be lepidolite; and as it was possible that a study of it might have interest, an analysis was made by Mr. R. B. Riggs. The specimen chosen was originally rubellite, and its specific gravity, as determined by Mr. T. M. Chatard, was 2·87. Analysis as follows:—

SiO_2	43·90
Al_2O_3	38·71
Fe_2O_3	0·58
FeO	0·25
MnO	0·04
CaO	0·41
MgO	0·05
Na_2O	1·05
K_2O	10·92
H_2O	4·25
F	none
B_2O_3	trace
	100·16

These results show clearly that the alteration product is not lepidolite but damourite, a fact which could hardly be altogether unexpected. The material analysed was received from Mr. N. H. Perry, of South Paris, Maine.

Norway.—The specimens from this locality were partly collected during a field expedition, and partly received

* Abstract of a Paper to appear in full in a forthcoming *Bulletin of the U.S. Geological Survey.*

* See G. F. Kunz, *Proc. Amer. Assoc.*, 1885.

† See Third Supplement to Dana's "Mineralogy," pp. 78, 79.

from N. H. Perry. The lepidolite was of two varieties; one pale brown and very finely granular, the other much coarser in structure and white. Most of the associated tourmaline has a peculiar dark oily-green tint; and with many of the specimens a rose-red earthy clay was associated. A partial analysis of the latter was published in "Bulletin No. 9 of the U.S. Geological Survey," but a re-analysis seemed to be desirable and was therefore made by Mr. Riggs. The results are subjoined and show that the mineral approaches nearly to cimolite. The difference from the earlier analysis indicates a non-homogeneity of composition. As to the genesis of the clay, nothing can be said with certainty.

SiO_2	66·86
Al_2O_3	22·23
Fe_2O_3	0·47
FeO	0·18
MnO	0·07
CaO	0·42
MgO	0·33
Li_2O	0·29
Na_2O	0·46
K_2O	0·18
H_2O	8·26
F	0·06
	99·81

Formula, $Al_2H_4Si_5O_{15}$.

Auburn.—In the western part of this town, near the Minot line, there are two localities for lepidolite, less than half a mile apart. The one longest known is small and unimportant, but the other on the farm of G. C. Hatch, has been quite thoroughly developed.* It has yielded many gem tourmalines, mostly of the paler tints, some remarkable apatites, and perhaps the best crystallisations of lepidolite so far known. The latter mineral occurs in the ordinary purplish coarsely granular form and also in extraordinary perfection as a border upon muscovite; the broad plates of the latter being practically encircled by aggregations of small crystals of the lithia mica. Some specimens of this type have also been found at Paris.

As it was hoped that this mode of occurrence of lepidolite might throw some light upon its genesis, three analyses of Auburn material were made by Mr. Riggs: first, of the common granular variety, secondly of the border upon muscovite, and finally of the latter mineral from the centre of the second specimen. The muscovite analysis came out as follows:—

SiO_2	44·48	Na_2O	2·41
Al_2O_3 ..	35·70	K_2O	9·77
Fe_2O_3 ..	1·09	H_2O	5·50
FeO	1·07	F	0·72
MnO ..	trace		100·84
CaO	0·10	Less oxygen ..	0·30
MgO	trace		100·54
Li_2O	trace		

About these results there is nothing unusual.

For convenience the analyses of lepidolite, all by Mr. Riggs, may be given in one table. The water in every case was determined directly by means of the Gooch tubulated crucibie, and most of the lithia separations were effected by a new process, lately devised in this laboratory by Dr. F. A. Gooch, and shortly to be published in full. In the Auburn and Norway lepidolites, however, the old phosphate method was used. The fluorine estimations were all by the Berzelian process. In the figures given for $(KRbCs)_2O$, we have actual determinations based upon the amount of chlorine in the mixed chlorides, and not a mere computation as K_2O from the weight of the chloroplatinates. All important estimations were checked in duplicate, and the table of results represents mean values. Seven analyses were made, as follows:—(See Table, next page).

* See G. F. Kunz, *Am. Journ. Science*, III., xxvii., 303.

As regards cæsium and rubidium the Maine lepidolites offer some points of difference. In the Rumford material an ordinary analysis shows neither; but a special examination upon the alkalies from 150 grms. of mineral gave a spectroscopic trace of rubidium. The Paris lepidolite showed traces of both metals, while the material from Hebron, Norway, and Auburn was much richer. On these lepidolites approximate estimations were made, as follows:—

	Hebron. Granular.	Norway. White.	Auburn. Granular.	Auburn. Border.
K_2O ..	11·44	8·82	10·51	8·03
Rb_2O } ..	0·77	3·73	1·29	2·44
Cs_2O }		0·08	0·45	0·72
	12·21	12·63	12·25	11·19

In these determinations the cæsium was separated as stannic chloride, and the other two metals were computed indirectly from the amount of chlorine in the mixed chlorides. The results have only a comparative value, and no sharp accuracy can be imputed to them. The methods of separation for the three metals are still far too defective.

The foregoing analyses of the Maine lepidolites, covering several distinct types of the mineral from five different localities, indicate a great constancy of composition. The essential indentity of the mineral with that from Rozena and Cornwall is also shown by the several published analyses of the latter, while the lepidolite from Juschakova is slightly different, in that it contains some manganese replacing aluminum, higher fluorine, and a little chlorine. In most of the analyses the water and fluorine appear to vary reciprocally, suggesting the ordinary replacement of the latter element by hydroxyl. With this slight assumption the formula for lepidolite may be written thus:—

$$Al_2LiKF_2Si_3O_9;$$

a formula which has long had general acceptance, but which now rests upon the surer basis of a wider range of analytical data. It corresponds to the following theoretical composition.

	Calculated.		Found.	(Riggs).
SiO_2	49·18		48·80 to	51·52
Al_2O_3	27·87		24·99	28·80
Li_2O	4·09		3·87	4·98
K_2O	12·81	$(NaKRbCs)_2O$	12·07	13·68
F	9·84	(FH_2O)	6·69	8·25

Most of the variations are no greater than we should expect to find in material so difficult to secure in absolute purity as lepidolite. The granular structure of that species is peculiarly favourable to the presence of inclusions, as for example of albite, to which probable impurity some of the soda shown by the analyses may be due. The greatest difference is in the case of fluorine; although some of the foreign analyses, notably Rammelsberg's analysis of the Juschakova mineral, contain very nearly the full theoretical amount.

II. The Iron-Lithia Micas of Cape Ann.

In the granite quarries of Rockport, Massachusetts, near the extremity of Cape Ann, there are occasional felspathic veins which contain the rarer minerals danalite, cyrtolite, fergusonite, and amazon-stone, together with certain remarkable micas. One of the latter, cryophyllite, was described by Cooke in 1867;* who also analysed an associated "lepidomelane," to which Dana afterward gave the name of annite. The vein from which Cooke obtained his material was long ago blasted away or covered up; but other veins of like nature are still accessible, and from one of them the micas examined in this laboratory were obtained. They were collected by the original discoverer of the locality, Mr. W. J. Knowlton, of Boston, and were, to all appearance, identical with the micas described by Cooke. Among the specimens the two types were clearly recognisable; the one a dark greenish-black lithia mica,

* *American Journal of Science*, II., xliii., 217.

Analyses of Lepidolite.

	A. Purple. Rumford.	B. Foliated. Paris.	C. Granular. Hebron.	D. Border. Auburn.	E. Granular. Auburn.	F. White. Norway.	G. Brown. Norway.
SiO_2	51·52	50·92	48·80	49·62	51·11	49·52	50·17
Al_2O_3	25·96	24·99	28·30	27·30	25·26	28·80	25·40
Fe_2O_3	0·31	0·30	0·29	0·31	0·20	0·40	0·87
FeO	undet.	0·23	0·09	0·07	0·07	0·24	0·45
MnO	0·20	trace	0·08	0·55	0·17	0·07	0·23
CaO	0·16	trace	0·10	—	0·12	0·13	undet.
MgO	0·02	trace	0·07	—	0·01	0·02	undet.
Li_2O	4·90	4·20	4·49	4·34	4·98	3·87	4·03
Na_2O	1·06	2·11	0·74	2·17	1·43	0·13	13·40
$(KRbCs)_2O$	11·01	11·38	12·21	11·19	12·25	12·63	
H_2O	0·95	1·96	1·73	1·52	0·94	1·72	2·02
F	5·80	6·29	4·96	5·45	6·57	5·18	5·05
	101·89	102·38	101·86	102·52	103·11	102·71	101·62
Less oxygen	2·44	2·64	2·02	2·29	2·76	2·18	2·13
	99·45	99·74	99·84	100·23	100·35	100·53	99·49

cryophyllite; and the other a black, brilliant lepidomelane. In some specimens the cryophyllite formed a border upon the broad plates of the other mica, precisely as in the association of lepidolite and muscovite at Auburn. The resemblance in this particular was curiously striking; only the Rockport minerals are less conspicuous than those from Maine, since they lack the contrast of colour which gives the latter their beauty.

The cryophyllite varies considerably in outward character, and three well marked types of it were analysed by Mr. Riggs. They may be described as follows:—A. Broad-foliated, brilliant, blackish-green. B. Paler, dull-green, less lustrous, seemingly altered. C. An aggregation of minute six-sided prisms, dark green, almost granular in appearance, resembling some chlorite. Mean results are given.

	A.	B.	C.	Cooke's Analysis.
SiO_2	51·96	51·46	52·17	51·49
Al_2O_3	16·89	16·22	16·39	16·77
Fe_2O_3	2·63	2·21	4·11	1·97
FeO	6·32	7 63	5·99	7·98
MnO	0 24	0·06	0·32	Mn_2O_3 0·34
CaO	0·12	trace	trace	—
MgO	0·03	0·17	trace	0·76
Li_2O	4·87	4·81	4·99	4·06
Na_2O	0·87	0·89	0·63	trace
K_2O	10·70	10·65	10·48	13·15
H_2O	1·31	1·12	1·46	—
F	6·78	7·44	7·02	SiF_4 3·42
	102·72	102·66	103·56	99·94
Less oxygen	2·86	3·11	2·95	
	99·86	99·55	100·61	

It will at once be seen that the three samples examined by Mr. Riggs were sensibly identical, and not far in composition from the material analysed by Cooke. In the latter the fluorine amounted to 2·49 per cent, which is only about one-third of the figure found in this laboratory, while the silica, plus that represented in the SiF_4, is sensibly higher. The integrity of the species, however, seems to be clear; and it cannot be identified with zinnwaldite. Empirically, as deduced from the new analyses, the formula of cryophyllite may be written—

$$FeH_3K_3Li_4Al_4F_4(SiO_3)_{10}; \text{ or, } R'_6Al_2F_2(SiO_3)_5.$$

With the "lepidomelane" or annite, quite unexpected results were obtained. The material analysed by Mr. Riggs was black, brilliant, broadly foliated, and apparently very pure. His figures are given in contrast with those published by Cooke.

	Riggs.		Cooke.
SiO_2	31·96		39·55
TiO_2	3·42		—
Al_2O_3	11·93		16·73
Fe_2O_3	8·06		12·07
FeO	30·35		17 48
MnO	0·21	Mn_2O_3	0·60
CaO	0·23		—
MgO	0·05		0·62
Li_2O	trace		0·59
Na_2O	1·54		trace
K_2O	8·46		10·66
H_2O	4·25		1·50
F	trace	SiF_4	0·62
	100·46		100·42

It is at once evident that two entirely distinct micas are here represented, and the question is raised whether the Rockport granites may not contain a series of complex isomorphous mixtures. Cooke, indeed, pointed out the isomorphism of cryophyllite with his samples of annite, and showed that the lithia and fluorine in the latter were probably due to admixtures of the former. We now see that at least three micas are involved in the problem to be solved, and the difficulty of establishing definite formulæ is enormously increased. For the present, approximate formulæ only can be assigned to these micas, involving several assumptions, and representing probabilities rather than complete interpretations of the facts. If we unite the groups SiO_2 and TiO_2 in the new annite, and regard the ferric iron as belonging partly with the alumia, and partly as having been derived by oxidation from the ferrous state, we have the following general formulæ for the two analyses.

Annite, Cooke, .. $R'_8Al_4(SiO_4)_5$.
Annite, Riggs, .. $R'_{14}Al_2(SiO_4)_5$.

For the former, the quivalent of R'8 is approximately $K_2H_2Fe''_2$, and for the latter it is $K_2H_4Fe_4$. These values correspond to the following percentage compositions:—

	Cooke.	Riggs.
SiO_2	39·5	36·6
Al_2O_3	26·8	12·4
FeO	18·9	35·1
K_2O	12·4	11·5
H_2O	2·4	4·4
	100·00	100·00

Attention has already been called to the fact that some specimens of cryophyllite form borders upon plates of annite, precisely as the lepidolite of Auburn is arranged

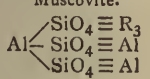
about nuclei of muscovite. It accordingly becomes quite probable that similar relations connect the two pairs of minerals; and upon these relations the formulæ so far deduced shed some light. In each case we have a mineral with metasilicate ratios implanted upon an orthosilicate; and a derivability of the one from the other is forcibly suggested. Structural analogies also appear; for in each couplet we have evidence of a common type of nucleus, which may be represented thus:—

Lepidolite nucleus, $Al(SiO_3)_3$. Cryophyllite nucleus, $Al_2(SiO_3)_3$.
Muscovite nucleus, $Al(SiO_4)_3$. Annite nucleus, $Al_2(SiO_4)_3$.

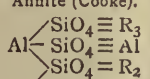
The development of complete structural formulæ from these nuclei is rendered difficult by our ignorance of the part which fluorine plays in such compounds. In the ordinary lepidolites it is easy to conceive of it as united with the aluminum in the univalent group AlF_2; but in the iron micas and phlogopite a similar representation is unsatisfactory. A different solution of the problem is therefore to be sought, and it may be found by an application of the well-recognised principle that fluorine and hydroxyl can replace each other isomorphously.

If now we start from orthosilicic acid, $Si(OH)_4$, and regard the hydroxyl groups as successively replaceable by atoms of fluorine, we can conceive of a series of acids ranging from $Si(OH)_4$ to SiF_4; and with the aid of such a supposition many of the fluoriferous silicates may be rationally explained. For example, the acid $SiF(OH)_2$ may be considered, and its nucleus, $SiFO_3$, a trivalent residue, can be applied to the discussion of the lithia micas. Upon this basis the formulæ for lepidolite and cryophyllite become curiously significant, especially when written in direct comparison with the structures assignable to muscovite and annite respectively. In every case the assumption is made that double salts are to be represented as substitution derivatives of normal salts of similar type, and the results appear as follows:—

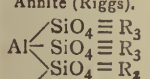
Muscovite.



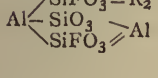
Annite (Cooke).



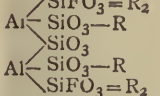
Annite (Riggs).



Lepidolite.

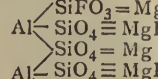


Cryophyllite.



To zinnwaldite, as represented by the published analyses, a probable structure is not easily assignable; and the variations in its composition suggest that the specimens examined have been mixtures of isomorphous compounds. It needs to be thoroughly reinvestigated, not only for itself, but also in its relations to whatever other micas may be associated with it. The matter of association can never, in the study of the micas, be safely neglected.

Although the formulæ herein assigned to annite and cryophyllite are to be regarded merely as trial hypotheses, there can be little doubt that the ratios between the sesquioxides and the silica are correctly given. These ratios are the ratios indicated by the published analyses of phlogopite; with which, therefore, rather than with ordinary lepidomelane, the Rockport micas are chemically to be classed. Zinnwaldite is already so classed by Tschermak and others, and cryophyllite falls easily into the same category. The subjoined formula fairly represents a typical phlogopite.



—*American Journal of Science*, Nov., 1886.

ON RED AND PURPLE CHLORIDE, BROMIDE, AND IODIDE OF SILVER: ON HELIOCHROMY AND ON THE LATENT PHOTOGRAPHIC IMAGE.*

By M. CAREY LEA, Philadelphia.

Part I.

In this series of papers it will be my object to show:—

(1.) That chlorine, bromine, and iodine are capable of forming compounds with silver exhibiting varied and beautiful colouration, peach-blossom, rose, purple, and black. That these compounds (except under the influence of light) possess great stability: that they may be obtained by purely chemical means and in the entire absence of light.

(2.) That of these substances the red chloride shows a tendency to the reproduction of colours. It seems not improbable that the material of the infinitesimally thin films obtained by Becquerel, Niepce de St. Victor, Poitevin, and others in their experiments on heliochromy may be the red chloride.

(3.) That these substances, formed by purely chemical means, constitute the actual material of the latent or invisible photographic image, which material may now be obtained in the laboratory without the aid of light and in any desired quantity. They also form part of the visible product resulting from the action of light on the silver haloids.

For more than a generation past, the nature of the latent photographic image, that which forms the basis of development, has been in dispute. Two theories have been maintained. According to the one, the first effect produced by light is simply a physical change, predisposing the elements of the silver haloid to dissociation, so that when a reducing agent is applied the molecules so affected yield more quickly to its influence. According to the other theory, the invisible image is formed of a sub-salt (sub-chloride, &c.). Observations which I published many years ago led me strongly to the first-mentioned of these theories. But of late years results have been obtained not easily reconcilable with it. On the other hand, the theory that the latent image is formed of sub-salt is opposed to striking facts. Silver subchloride, for example, is an unstable substance, quickly destroyed by dilute nitric acid. But I have formed a latent image on silver chloride, and after exposing it for five minutes to the action of strong nitric acid (sp. gr. 1·36) have developed the image without difficulty; the same with silver bromide. Evidently these images, which so strongly resisted the action of undiluted acid, could not be formed of simple subchloride and subbromide of silver, substances quickly destroyed by it.

In the desire to find a satisfactory explanation of the nature of the image based on adequate chemical proof, I have devoted nearly three years of laboratory work to this and to closely allied subjects. I am led to the conclusion that neither of the older views is correct. A truer theory seems to be deducible from the result of some experiments which I published in 1885, to the effect that the silver haloids were capable of uniting with certain other substances, much in the same way that alumina forms lakes. When a silver haloid was precipitated in the presence of certain colouring-matters they combined with it, and, though soluble in water, they could not be subsequently washed out. They had formed a somewhat stable compound, although the proportion of colouring-matter was very small in comparison with the haloid,—evidently much too small to represent a stoichiometrical composition.

Now I find that a silver haloid may, in the same way, unite with a certain proportion of its own sub-salt, which

* *Amer. Journ. of Science*, 3rd Series, vol. xxxiii., p. 349.

by this union quite loses its characteristic instability, and forms a compound of great permanence.

Another explanation is possible: the sub-salt may combine with the normal salt, not in the manner above described, but in stoichiometrical proportion, and this compound may be diffused through ordinary silver haloid. I have not been able to find any reaction decisive between these explanations,* but the general behaviour of the substance seems rather to indicate the first-named explanation as the true one. When the red chloride, for example, has been boiled with dilute nitric acid for a few moments to eliminate any uncombined subchloride, the proportion of subchloride left has never exceeded 8 or 9 per cent in over thirty specimens analysed. If we took this to represent a compound in equivalent proportions, we should have to suppose the union of at least twenty equivalents of AgCl with one of Ag_2Cl, which is improbable. If we suppose that these coloured substances containing from less than one-half per cent up to eight or nine per cent of Ag_2Cl consist of a compound of one equivalent of subchloride united to a small number of equivalents of normal chloride, mixed mechanically with a large quantity of normal chloride, then it would be improbable that specimens could not be obtained containing a larger proportion of this compound and consequently of Ag_2Cl, but, as already said, specimens containing more than 9 per cent after thorough treatment with nitric acid to remove the uncombined subchloride I have never obtained: generally the amount is less.

Even when silver chloride, bromide, or iodide contains as little as one-half of one per cent of sub-salt combined, its properties are greatly changed. It has a strong colouration and its behaviour to light is altered. Even a much less quantity, one inappreciable to analysis, is capable of affecting both the colour and the behaviour to light.

It is one of these latter forms of this substance that constitutes the actual material of the latent photographic image: adequate proof of this will be given in the second part of this paper.

Red Silver Chloride.

Of the three haloids, the chlorine salt is the most interesting, because of its relations to heliochromy: it is also the most stable of the three compounds and exhibits perhaps a finer variety of colouration, though the bromide and iodide are also obtainable of very beautiful tints. The chloride shows all the warm shades from white to black through the following gradations: white, pale flesh colour, pale pink, rose colour, copper colour, red purple, dark chocolate, black.

These compounds are obtained in an endless variety of ways: by chlorising metallic silver; by acting on normal chloride with reducing agents; by partly reducing silver oxide or silver carbonate by heat and treating with HCl; by forming sub-oxide or a sub-salt of silver and treating with HCl followed by nitric acid; by acting on sub-chloride with nitric acid or an alkaline hypochlorite, &c.; by attacking almost any soluble salt of silver with ferrous, manganous, or chromous oxide, &c., followed by HCl; by reducing silver citrate by hydrogen and treating it with HCl; by treating a soluble silver salt or almost any silver solution with potash or soda and almost any reducing agent, cane-sugar, milk-sugar, glucose, dextrine, aldehyd, alcohol, &c., and supersaturating with HCl; there is no organic easily oxidisable substance that I have tried that has failed to give this reaction. Also almost any salt of silver exposed to light, treated with HCl and then with hot strong nitric acid, yields it. Almost any of these classes represents a long range of reactions, each susceptible of endless variation. In fact, the more the matter is studied, the more extended the range of reactions is found to be that give rise to the formation of this substance. To show how slight an influence will lead to the production of red chloride instead of white: if freshly precipitated argentic oxide is mixed for a few moments with starch or tragacanth paste and is then treated with HCl, the result is, not white, but pink silver chloride. Even raw starch flour mixed with silver oxide will in a few moments cause it to give a pale flesh-coloured chloride with HCl. Boiled starch or tragacanth paste does this more quickly and acts more strongly, even in the cold, and still more if heat is applied.

Although red is probably the most characteristic colour of this substance, so that I have spoken of it above as red chloride, nevertheless this hardly seems a proper name for a substance that is often purple, chocolate, or black, sometimes brown or even ochreous, sometimes lavender or bluish, and is probably capable of assuming every colour of the spectrum. To call it argento-argentic chloride would infer a stoichiometrical composition that, as already mentioned, seems very uncertain, too much so to serve as the basis of the name. Therefore, and as these substances have been hitherto seen only in the impure form in which they are produced by the continued action of light on the normal salts, it might be convenient to call them photosalts, photochloride, photobromide, and photoiodide instead of red or coloured chloride, &c., and thus to avoid the inexactness of applying the term red chloride to a substance exhibiting many other colours.

(To be continued).

* Silver chloride may be dissolved out by hot solutions of sodium or ammonium chloride, but the subchloride is at the same time decomposed. See beyond under head of "Reactions."

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

May 28th, 1887.

Prof. W. E. Ayrton, Vice-President, in the Chair.

Dr. S. P. Thompson read "*A Note on Transformers for Electric Distribution.*"

In the simple algebraic treatment of the dynamo several assumptions approximately true for well made machines are made use of. The author finds that a similar set of assumptions for transformers greatly simplifies the algebraic theory.

1. The iron, copper, and insulation are assumed good.
2. The reaction of the secondary on the primary (other than that desired) is small. Thus, if the primary be supposed to be supplied with constant mean current or constant mean potential difference, this is not to be altered by the current in the secondary.
3. No magnetic leakage: so that the coefficient of mutual induction is the geometric mean between their coefficients of self induction.
4. The quantities of copper in the primary and secondary are to be equal.

These assumptions are shown to be legitimate, and the ratio of resistances E.M.F.'s, currents, and coefficients of self-induction are expressed in terms of the ratio of the numbers of convolutions, which ratio is represented by

$$p = \frac{S_1}{S_2}.$$

From analogy with the dynamo it is shown that—

$$E_2 = \frac{\omega M}{\sqrt{R_1^2 + \omega L_1^2}} E_1,$$

where $\omega = 2\pi n$, E_1 and E_2 the E.M.F's of the primary and secondary respectively, and R_1 and L_1 the resistance and self-induction of the primary coil. If R_1 be neglible the above reduces to—

$$E_2 = \frac{\omega M}{\sqrt{\omega^2 L_1^2}} = \frac{E_1}{p} \text{ since } \frac{L_1}{L_2} = p^2 \text{ and } M = \sqrt{L_1 L_2}.$$

The latter part of the paper contains a general investigation of two neighbouring circuits, both having self-induction, and it is shown that the effective resistance of the primary is increased, and the self induction decreased by closing the secondary circuit.

Mr. Kapp said the investigations assumed the co-efficients of induction to be constants, and that the phases of current in primary and secondary were opposite. The former being by no means true, he asked what values were to be taken? and he believes the phases of current are not opposite in ordinary transformers.

Mr. Swinburne protested against the use of formulæ to calculate the inductions, when the required data could be obtained much more accurately from Dr. Hopkinson's curves of Magnetisation of Iron. He also thought the curve of sines did not nearly represent the current curve for ordinary machines.

Mr. Bosanquet thought the effective magnetisation of a transformer would be different to that of a dynamo, for in the former, permanent magnetisation was not utilised.

In reply to Mr. Kapp and Mr. Swinburne, the author pointed out that, as the coefficients of induction enter in both numerator and denominator, it would not matter which set of values were taken if the resistance was small compared with ωL; and that self-induction tends to smooth out irregularities in the current curve.

Prof. Ayrton described a method of regulating a series transformer devised by himself and colleague some two years ago, based on analogy with a compound dynamo. Referring to the variation of L with current, he sketched a curve connecting them, obtained by Mr. Sumpner at the Central Institution, and mentioned that the E.M.F. curve of a Ferranti dynamo is an exact sine curve. He believes problems involving alternating currents would be greatly simplified by using a new set of measurable quantities, such as will render the equations as simple as possible.

At Prof. Thompson's request Prof. Ayrton exhibited a lecture experiment illustrating the action of transformers. The secondaries of two ordinary induction coils were joined in series through long fine wires, and an incandescent lamp placed in the primary circuit of one, lighted up on completing the primary of the other coil, in which a battery was placed.

"*On Magnetic Torsion of Iron Wires.*" By Shelford Bidwell.

This is an account of experiments made on the twisting produced by sending a current along magnetised iron wires, and the author shows that Wiedemann's explanation of these phenomena (by assuming a difference in molecular friction at the polar and lateral surfaces of magnetised molecules) is unsatisfactory. The wires were magnetised longitudinally by means of a solenoid in the axis of which the wires were suspended. To obtain consistent results it was found necessary to demagnetise the wire between the observations. This is done by reversed currents of gradually decreasing strength, and a simple arrangement of rheostat and commutator devised for this purpose was exhibited.

Two sets of experiments were made, in which the current in wire or solenoid was kept constant, whilst that in the other was varied. The amount of twisting does not increase continuously when the currents are increased, but attains a maximum when the inclination of the helix, representing the direction of magnetisation, is inclined at about 33° to the axis of the wire. When the current in the solenoid was kept constant, and that in the wire increased, permanent deflections remained on stopping the current. For small currents in the wire this deflection was diminished on starting the current, whilst stronger currents increased the deflection. For some intermediate value of the current no change took place, and this value was dependent on the current in the solenoid. Experiments were shown illustrating these phenomena.

NOTICES OF BOOKS.

Collection of Lectures on the Natural Sciences. Edited by Dr. Ernest Huth.—I. *The Periodic Law of the Atomic Weights and the Natural System of the Elements.* By Dr. E. Huth. (Sammlung Naturwissenschaftlicher Vorträge. Das periodische Gesetz der Atom Gewichte und des naturliche System der Elemente). Berlin: R. Friedländer und Sohn.

Dr. Huth begins his work in a manner consonant neither with historical accuracy nor with ethical justice. He says if we disregard the triads of Döbereiner (1829), "and the less-known studies of Newlands, the merit of having founded (*begründet*) the doctrine of the periodic system of the elements belongs to the Russian chemist Mendeleeff and the German Lothar Meyer." But if we wish to write the history of this great discovery correctly we have no right to disregard the labours of Newlands. That his views—though published in the Chemical News, copied into other Journals, and discussed before the Chemical Society—did not for some time attract the notice which they merited is very true; but is the fact that injustice has been done a fair argument for its continuance? Moreover, there can be no doubt either concerning the conclusions of Mr. Newlands or the dates when they were published, and these show that in "founding" the periodic system—though he did not use the term "periodic"—he has a priority of fully five years as compared with Prof. Mendeleeff. Concerning Prof. Lothar Meyer, it must be remembered that the great Russian chemist does not recognise his claim to any important share in the discovery.

Passing gladly from the historical and necessarily controversial portion, we note with great interest Dr. Huth's "Natural System." He arranges the elements in a double spiral, remarking that, as far back as 1870, Baumhauer proposed to express atomic relations.

It is not easy to give a full explanation of the author's scheme without a graphic representation such as he appends to his memoir. He draws seven radii departing from a common centre. On these he places in succession the numbers of the atomic weights, beginning near the centre with the lowest, at distances in accordance with a determined unit of measurement. The elements on the same radius form a natural family. In the accompanying table he begins with lithium on the first radius at the distance of 3·5 m.m. from the centre as its atomic weight = 7; "then follows glucinum on the next radius at the distance of 4·5 m.m., &c. If this arrangement is followed out quite mechanically, the elements which come upon one common radius,—in this case the second,—Be, Mg, Ca, Sr, Ba, Zn, Cd, and Hg, form a natural family, founded on similarity in their chemical and physical behaviour." On the first radius are found Li, Na, K, Cu, Rb, Ag, Cs, and Au. On the third come B, Al, Sc, Ga, Yt, In, La (accompanied by Ce and Di), and Th. On the fourth we find C, Si, Ti, Ge, Zr, Sn, Tl, and Pb. The fifth radius holds N, P, V, As, Nb, Sb, Ta, Bi, and an undiscovered element X. On the sixth radius follow O, S, Cr, Se, Mo, Te, W, and U. The seventh radius holds F, Cl, Mn (Fe, Ni, and Co very close together), Br, Ru (with Rh and Pd adjacent), I, and Ir, with Pt and Os. The ninth radius is blank.

It will at once strike the reader that in this arrangement hydrogen is wanting. We neither find it indicated in the diagram, nor do we see any explanation of its absence.

In each family—*i. e.*, on each radius—the author recognises a typical element, the one standing nearest the centre and having the lowest atomic weight, and two alternating groups. Thus the first family, monovalent generators of bases, contains the potassium group, K, Rb, and Cs, all electro-positive, forming very powerful bases, decomposing water with violence, and having gradually

increasing specific gravities (0·87—1·52—2), and high gradually-increasing atomic volumes (45·4—56·3—67·5). Their spectra are homologous.

The copper group Co, Ag, Au have also increasing specific gravities (8·9—10·6—19·3), and atomic volumes in which no continuous increase can be traced (7·3—10·18—10·15). Copper and silver have homologous spectra. To this family the author assigns two typical elements, Li and Na.

The author's scheme, as shown in the diagram, requires the construction of a double spiral. One of these spirals is expressed by an unbroken line and the other by a dotted line. So far as the typical elements of each family are concerned these two spirals run together, but afterwards they separate. Thus, on the first radius, K, Rb, and Cs, are arranged on the unbroken line, and Cu, Ag, and Au on the dotted line.

The author's arrangement brings the properties of the elements and their relation to the atomic weights very clearly into view. We cannot perceive that he takes the origin of the elements as absolutely distinct and primordial, or as developed from possibly simpler forms of matter, into consideration.

This little work, however, is well worth the heedful notice of all who feel an interest in the development of the periodic system.

Societatum Litteræ. 1887, No. 1 and 5.

We have no hesitation in pronouncing this new undertaking decidedly useful. Its object is to give each month the titles of the papers read before the Academies and other learned Societies of all nations. No attempt is made to give any idea of the contents of each memoir, which could not, of course, be done at any useful length without rendering the new Journal exceedingly bulky, and consequently expensive.

The sciences taken into account are astronomy, meteorology, physics, chemistry, zoology (for which biology would be a preferable synonym, as it seems to include botany), anthropology, mineralogy, geology, palæontology, and hygiene. Other sciences will be noticed only when bearing directly upon some one of the above-mentioned subjects.

The title is given in Greman, English, and French. We must, however, beg to remind the Editor that the English equivalent for "Naturwissenschaften" is not "Natural History," but "Natural Sciences."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 4.

Phosphoric Acid in Manurial Phosphates.—E. Aubin.—From the *Moniteur Scientifique.*

Determination of Indigo in Dyed Woollens.—Taverne.—The author exhausts a given square surface of the material with chloroform in Soxhlet's extraction apparatus, evaporates the extract to dryness, weighs the residue, dissolves it in sulphuric acid, and determines colorimetrically or by titration with solution of chloride of lime.

Determination of Resin in Soaps and Fats.—A. Grittner and J. Szilasi (*Chemiker Zeitung*).—According to the authors the methods of Sutherland, Gottlieb, and Heiner do not give quantitatively useful results. They recommend a modification of Gladding's process. From 1 to 2 grms. soap are dissolved with heat in 80 per cent alcohol, the solution, if acid, is neutralised with ammonia, mixed with excess of a 10 per cent alcoholic solution of calcium nitrate, and filtered when cold. The filtrate passes through at first turbid, and must be repeatedly poured back. The precipitate is washed several times with 80 per cent alcohol, mixed in a roomy flask with an excess of silver nitrate solution, and diluted with three volumes of water. After some shaking the precipitate (if a sufficiency of silver solution has been used) collects on the surface, and the solution is nearly clear. It is filtered and the precipitate is washed with cold water until the washings no longer give a precipitate with hydrochloric acid. The washed precipitate is dried at 70° to 80°, and washed with ether into the same flask in which was the silver precipitate, and which must have been dried internally in the meantime. After some time the ethereal solution is filtered through a dry filter into a graduated 100 c.c. cylinder, and the undissolved portion is washed with ether until the filtrate makes up 90 c.c. The ether which flows through last must be colourless; if 90 c.c. do not suffice, a larger graduated cylinder of about 250 c.c. may be used. The solution is then mixed with about 10 c.c. of dilute hydrochloric acid, well shaken for a long time; the cylinder is then filled with ether or hydrochloric acid up to the mark and shaken again. If the operation has been well managed the precipitate of silver chloride settles quickly, and the ethereal solution of the resin is quite pure and transparent. The volume is read off, from 50 to 60 c.c. are taken with a pipette, the ether is distilled off, the residue dried at 100°, and the resin weighed. From the weight we must deduct 1·6 m.g. for every 10 c.c. of the ethereal solution on account of oleic acid which has been dissolved.

Examination of Commercial Glycerin.—L. Sullivan and E. E. Berry.—From the *Analyst.*

Impurities of Sodium Hydrocarbonate.—E. Mylius.—This salt sometimes contains thiosulphate.

Determination of Alkaloids in Belladonna Leaves.—W. Dunstan and F. Ransom.—From the *Pharm. Journal.*

Determination of the Cinchona Alkaloids.—J. E. de Vrij.—From the *Chemist and Druggist.*

Determination of Urea and of Total Nitrogen in Urine.—A series of researches made in Pflüger's Institute, for which we must refer to the original.

A New Form of Ureometer.—F. Bellamy.—From the *Journal de Pharmacie et de Chimie.*

Phenylhydrazine as a Reagent for Sugar in Animal Fluids.—R. v. Jaksch.—Phenylhydrazine can be used for the recognition of sugar in urine, and after removal of albumen in blood and serous liquids. Normal urine yields no phenylglucosazon, but it is regularly obtained from blood, &c.

Detection of Sugar in Urine by Fermentation.—M. Einhorn.—Yeast produces fermentation also in urines free from sugar, whence comparative experiments are always needful.

Reductive Power of Normal Urine.—M. Flückiger and C. Salkowski.—According to the former author normal human urine has a reductive power equal to that of a 0·15 to 0·25 per cent solution of glucose. Salkowski finds the reductive power of urine higher.

Quantitative Determination of Glucogen.—Bruecke.—As sources of error the author points out the possibility of an alteration of the compound by the reagents employed, and also the difficulty of completely extracting it from the tissues under examination.

Detection of Chloral Hydrate in Animal Fluids.—Baron H. Tiesenhausen.—The author applies the "shaking out" method used in searching for alkaloids. Absolute ether is the best agent, acetic ether is almost as good, whilst petroleum ether, chloroform, and benzene are not applicable.

Detection of Petroleum in the Animal Body.—W. Jacobson.—The "shaking" method is here recommended. Petroleum ether in the cold takes up mere traces of chloroform, ether, acetic ether, benzene, and chloroform are effectual.

Recognition of Mercury. — T. Lecco. — Metallic mercury, obtained on examining poisoned food for volatile poisons, floated at first as a dark scum upon the colourless distillate. On remaining upon the filter it was converted into metallic globules, recognisable as mercury. Mercuric chloride, which had been mixed with fish and sourkrout after six weeks could not be extracted with alcohol.

Cheese Poison.—Victor C. Vaughan.—The author has isolated from poisonous cheese a ptomaine in acicular crystals. He names it tyrotoxicon. It reduces a mixture of ferric chloride and potassium ferrocyanide, as well as iodic acid, and it is not precipitated by the general reagents for alkaloids.

Studies on the Behaviour of the Ptomaines in Chemico-legal Investigations. — K. Tamba. — This paper will be inserted at length.

Atomic Weight of Cerium.—B. Brauner.—The author finds Ce = 140·2210 (O = 16) or Ce = 139·8707 (O = 15·96). His method of purification was to convert the crude cerium oxides into nitrates, and precipitate the basic nitrate by pouring the concentrated solution of the neutral salts into hot water. By fractionated precipitation in this manner repeated eleven times, he obtained preparations, the purity of which was proved by determining the atomic weight of the metal (or metallic mixture) present.

MEETINGS FOR THE WEEK.

MONDAY, 6th.—Society of Chemical Industry, 8. "The Alkaloids—the Present State of Knowledge concerning them, and the Method employed in their Investigation," by Dr. H. E. Armstrong. "Notes of a Recent Visit to some of the Petroleum-Producing Territories of of the United States and Canada," by Boverton Redwood.

TUESDAY, 7th.—Royal Institution, 3. "The Hellenism of Alexander's Empire—Macedonia and Greece," by the Rev. J. P. Mahaffy, D.D.

—— Institution of Civil Engineers, 8. (Anniversary).

WEDNESDAY, 8th.—Geological, 8.

—— Microscopical, 8.

THURSDAY, 9th.—Royal Institution, 3. "The Hellenism of Macedonia's Empire—Egypt," by the Rev. J. P. Mahaffy, D.D.

—— Mathematical, 8.

FRIDAY, 10th.—Royal Institution, 9. "Aquileia, the Precursor of Venice," by Thomas Hodgkin, D.C.L.

—— Astronomica, 8.

—— Quekett Club, 8.

SATURDAY, 11th.—Royal Institution, 3. "The Helenism of Alexander's Empire," by the Rev. J. P. Mahaffy, D.D.

—— Physical, 3. Exhibition of Puluj Vacuum Tubes, by Dr. Warren de la Rue. "Note on Beams Fixed at Both Ends" and "Note on Magnetic Resistance," by Profs. Ayrton and Perry.

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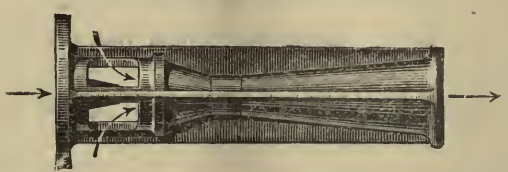

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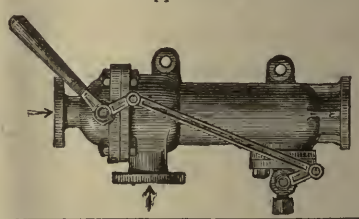

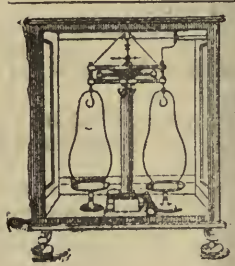

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THE CHEMICAL NEWS.

VOL. LV. No. 1437.

SILVER SUBOXIDE.

By G. H. BAILEY, D.Sc., Ph.D., The Owens College.

IN the number of the *Berichte* recently issued (May 23rd) is a communication from Dr. Otto von der Pfordten, in which he considers "that he has proved with certainty the existence of compounds of suboxide of silver." Having confessed that Wöhler's original method with citric acid is out of the question, he gives two methods of preparation which are in some respects new.

In one of these he adds sodium hydrate solution to neutral tartrate of soda containing some nitrate of silver, and obtains a black powder, "which is at all events the suboxide of silver in combination with an organic acid, probably tartaric," and at the same time there is "probably formed a mixture of organic acids." The powder cannot be filtered; it is decomposed by almost every reagent, and it is purified (*sic*) by washing it by decantation with a solution of sodium sulphate! This tartrate, by the action of caustic alkalies, yields the suboxide which is stable in presence of caustic potash, but, singularly enough, is decomposed by pure water.

Notwithstanding the extreme difficulty, indeed the impossibility, of washing such oxides free from alkalies by decantation, and the importance that in this case every trace of organic matter should be removed, no mention is made of any special precautions in this direction.

In spite of the high degree of probability that metallic silver is contained in the product, and that oxygen is mechanically retained, no criterion (beyond assertion) is given of the homogeneous character of the suboxide.

The interest of the paper centres on an accurate analysis, which to be satisfactory must—for manifest reasons—be made on tolerably large quantities of substance · and yet no details whatever are given of such an analysis, except that a certain volume of a very dilute solution of permanganate of potash was used for the titration. And even if these matters were quite satisfactory the problem is a much more complicated one, for we have in the case in question one or all of the following substances:—

(1) Extremely finely-divided silver
(2) Oxide of silver;
(3) Suboxide of silver.

Each of these retains oxygen, moisture, and alkalies with very great tenacity, and of the behaviour of such physical associations with reagents very little is known. Unless indeed it is possible to prepare, as Wöhler attempted to do, a pure salt of the suboxide of definite composition, the problem is almost incapable of a satisfactory solution. Of course the communication is only given as a preliminary one, but the composition of the suboxide (and any remarks in this note apply equally to the subsulphide) is definitely stated, no lack of details of minor importance are given, and the behaviour with various reagents.

My object is not to criticise the paper, which is indeed more open to criticism in parts not touched upon, but only to point out that the conclusions drawn are not warranted by the evidence.

Atomic Motion.—On Thursday, June 16th, at 8 p.m., Prof. A. W. Williamson, F.R.S., will deliver a Farewell Address to the Chemical and Physical Society in the Chemical Theatre of University College. Subject: "A Few Words on Atomic Motion." Sir Henry E. Roscoe, M.P., has kindly consented to take the chair.

THE HIGHER OXIDES OF COPPER.*

By THOMAS B. OSBORNE.

Copper Dioxide.—When copper hydroxide is treated with hydrogen dioxide at a temperature near o° C., a brown precipitate is formed, which has been shown to contain nearly twice as much oxygen as copper oxide (CuO), and when acidified yields hydrogen dioxide. When the temperature is somewhat higher a grass-green precipitate is formed, which is sometimes yellow-green or yellow. Krüss (*Berichte*, 2593, 1834) has shown that the brown precipitate, when treated at o° C. for some days with excess of hydrogen dioxide and frequently shaken, can be filtered, and washed first with alcohol and then with ether, and when entirely freed from water can be dried at 100° C. It then has the composition of CuO_2, H_2O, or H_2CuO_3. When moist, Krüss found that it began to decompose above +6° C. Above this temperature he obtained a grass-green precipitate, which began to decompose above +12° C. He was unable to analyse this latter, as it decomposed readily.

Brodie has shown that if hydrogen dioxide be added to a salt of copper in solution, and then soda, a yellow precipitate is formed.

Krüss obtained a yellow precipitate in too small quantity to analyse, by fusing copper oxide with sodium chloride with access of air. He thought this was a higher oxide of copper and anhydrous, and suggested that it might be the same as Brodie's oxide. Having been unable to find any investigations of the composition of these variously coloured precipitates, I thought it worth while to try and straighten them out. I found that if copper hydroxide (prepared by precipitating nitrate of copper with soda, and washing thoroughly with cold water by decantation, so as to keep the copper hydroxide in a state of the finest possible subdivision) was treated with hydrogen dioxide in small amounts, a green precipitate was formed, which by further action of hydrogen dioxide was changed into a brown. This brown precipitate was yellow by transmitted light, but dark brown by reflected light. When a small amount was shaken up with water it appeared yellow. I found that by mixing increasing amounts of hydrogen dioxide with copper hydroxide the colour of the precipitate varied from a yellow with a greenish tinge through yellow to brown. I made a number of preparations thus varying in colour, and, after washing by decantation free from hydrogen dioxide, determined the hydrogen dioxide set free by dissolving the precipitate, suspended in water, with dilute sulphuric acid. By using a solution of potassium permanganate of known strength the hydrogen dioxide set free was easily determined, the

		Per cent.	Weight.	Ratio.
I. Grass-green	CuO	82·35	0·6679	12·2
	H_2O	16·29	0·1322	
	O	1·36	0·0110	1·0
		100·00		
II. Grass-green	CuO		0·2717	12·7
	O		0·00422	1·0
III. Yellow-green	CuO		0·3040	7·5
	O		0·00814	1·0
IV. Yellower green	CuO		0·0701	5·14
	O		0·00275	1·0
V. Yellow (green tinge)	CuO		0·4757	4·2
	O		0·02271	1·0
VI. Yellow	CuO		0·0633	3·1
	O		0·00413	1·0
VII. Yellow-brown	CuO		0·2018	1·66
	O		0·02457	1·0
VIII. Brown (yellow tinge)	CuO		0·2847	1·48
	O		0·03893	1·0
IX. Brown	CuO		0·2813	1·2
	O		0·04669	1·0

* *Amer. Journ. of Science*, Third Series, vol. xxxii., p. 333.

copper in the solution was precipitated with hydrogen sulphide and determined, and the ratio between the excess of oxygen found by titration, and the copper oxide calculated. In this way I found the following ratio between the oxide of copper and the oxygen for the different coloured precipitates, with the exception of I., which was determined by filtering and washing the precipitate with water, alcohol, and ether, cooled to 0° C., drying at 100° C., and then heating in a tube in a current of dry air, weighing the water and copper oxide, and calculating the oxygen by difference.

From these analyses I concluded that the green precipitates were simply mixtures of the yellow with the blue, and that the yellow was a mixture of the brown and the green, the reddish brown colour of the dioxide of copper being complementary to the green, and thus destroying one another and leaving the yellow predominant. That these different colours are mixtures of CuO_2, H_2O, and $Cu(OH)_2$ was further supported by the fact that I could reproduce any shade of colour by mixing, at any temperature, the brown CuO_2, H_2O, with $Cu(OH)_2$ in proper proportions Furthermore, the fact that all yielded hydrogen dioxide, when dissolved in dilute acids without evolution of oxygen, is evidence in support of this view.

I found further that I could filter, wash, and dry these precipitates under the same conditions that Krüss employed for CuO_2, H_2O; and analysis by heating in a tube and weighing the water and copper oxide gave results similar to those obtained by determining the hydrogen dioxide set free by acids, as is seen by I., which was determined in this way, while II. was obtained by the permanganate method. I did not find that any of these precipitates decomposed at low temperatures when free from hydrogen dioxide. Krüss states that the brown precipitates begin to decompose above +6° C., and the green above +12° C. I found that when hydrogen dioxide was present there was a slow evolution of oxygen even below +5° C., which increased as the temperature rose. The precipitate, however, underwent no apparent change until boiled for a moment or two, when it suddenly yielded a large amount of oxygen and black CuO separated out. It would appear, then, that the decomposition below 100° C. is of the hydrogen dioxide, brought about by the action of the copper dioxide.

From the fact that no definite composition can be assigned to any of these various coloured precipitates except the blue copper hydroxide and the brown copper dioxide, that they all yield hydrogen dioxide with acids, that they show the same behaviour on heating, that the different colours can be produced by different amounts of hydrogen dioxide with the same amount of copper hydroxide, and that the colours may be reproduced by mixing the copper hydroxide and the copper dioxide, it seems reasonable to conclude that hydrogen dioxide forms but one higher oxide with copper.

Further, the yellow oxide obtained by Krüss by fusing copper oxide with sodium chloride cannot be the same as Brodie's, as suggested by Krüss, for the latter's compound must have been anhydrous while Brodie's is most probably a mixture of copper hydroxide with copper dioxide. When boiling a small amount of copper dioxide with water I obtained, after a few minutes, a bright yellow precipitate which did not decompose even when boiled for some time, nor on standing some days in a test-tube in the laboratory. There was too little to analyse, and I could not obtain it again. This may have been the same oxide as Krüss obtained by fusing copper oxide with sodium chloride. Lack of time prevented me from further investigating this compound.

Copper Sesquioxide.—Crum (*Liebig's Annalen*, lv., 213) described a higher oxide of copper which he obtained by mixing with 1 pound of bleaching-powder, solution sp. gr, 1·06, 50 grains sifted calcium hydroxide, and then adding to the solution, cooled to 0° C., 20 grains of copper oxide dissolved in 70 grains of nitric acid, sp. gr. 1·3. In this way he obtained a blue solution from which a black precipitate separated on standing for some hours. This precipitate evolved oxygen and floated on the top of the solution for some time. After twenty-four hours or more the oxygen ceased to come off, and the precipitate settled to the bottom in a dense condition. This precipitate, when finely divided, had a crimson tinge, and a brighter red colour when rubbed with a rod to a thin layer on glass. When soda was used instead of the suspended lime, he obtained a rose-red precipitate which would not settle. Crum considered the precipitate obtained with lime the same as that obtained with soda, and attributed the difference in colour to a difference in subdivision. He succeeded in washing the dense black precipitate by decanting with cold lime-water, and found that it contained no Cl and an excess of oxygen.

He made several determinations of the ratio between the copper and the oxygen by taking a weighed amount of copper oxide, treating it as described, and measuring the amount of oxygen evolved on acidifying. For 20 grains of copper oxide he obtains in six analyses—I. 1·875, II. 1·886, III. 1·748, IV. 1·915, V. 1·795, VI. 1·747 grains of oxygen. The mean is 1·828 grains. Cu_2O_3 would require 1·98 grains. By re-calculating these results, so as to show the ratio between the oxygen found and the copper oxide, I obtained the following numbers :—

I.	For 1 atom of oxygen,		2·14	copper oxide.
II.	,,	,,	2·15	,,
III.	,,	,,	2·30	,,
IV.	,,	,,	2·11	,,
V.	,,	,,	2·24	,,
VI.	,,	,,	2·30	,,

From this he concluded that the formula of the oxide was probably Cu_2O_3, and further that this oxide acted as an acid and was united with lime, forming a cuprate of calcium, although he obtained no proof that this latter supposition was correct. I repeated Crum's experiments in making this compound of copper with the results as described by him. Hoping to obtain a more accurate determination of the oxygen I tried the following method :—After the precipitate had settled the hypochlorite solution was poured off as far as possible, and then the flask filled up with lime-water and shaken in order to mix thoroughly. After allowing the precipitate to completely settle, 50 c.c. of the clear solution were drawn off and a known amount of ferrous sulphate solution run in, and, after standing some minutes, sulphuric acid added to dissolve the precipitated ferrous and ferric hydroxides, and then the excess of ferrous sulphate titrated off; 50 c.c. of the solution containing the copper precipitate were next drawn from the bottom of the flask and treated with the same amount of ferrous sulphate solution in the same way. The difference in the titre in the two cases represented the oxidation due to the excess of oxygen in the copper compound. The strength of the permanganate solution being known, the weight of oxygen was easily calculated. The first 50 c.c. of clear solution drawn off were in all cases examined for copper, but none was found. The copper in the other 50 c.c. was carefully determined, and the ratio between the copper oxide found and the excess of oxygen calculated. Thus I obtained the following results :—

A.

	Weight.	Ratio.
I.	CuO = 0·1888 grm.	CuO = 2·95
	O = 0·0129 ,,	O = 1·00
II.	CuO = 0·1261 ,,	CuO = 3·00
	O = 0·0084 ,,	O = 1·00
III.	CuO = 0·0861 ,,	CuO = 3·25
	O = 0·0053 ,,	O = 1·00

B.

		Washed thoroughly by decantation.
I.	CuO = 0·1524 grm.	CuO = 2·38
	O = 0·0129 ,,	O = 1·00
II.	CuO = 0·3182 ,,	CuO = 2·57
	O = 0·0249 ,,	O = 1·00

C.

I.	CuO = 0·2278 grm.	CuO = 2·83
	O = 0·0162 ,,	O = 1·00
II.	CuO = 0·0716 ,,	CuO = 2·40
	O = 0·0060 ,,	O = 1·00
III.	CuO = 0·1505 ,,	CuO = 2·25
	O = 0·0135 ,,	O = 1·00
IV.	CuO = 0·1217 ,,	CuO = 2·7
	O = 0.0092 ,,	O = 1·00

D.

Ferrous chloride was substituted for ferrous sulphate, with results as follows :—

	Weight.	Ratio.
I.	CuO = 0·1687 grm.	CuO = 2·93
	O = 0·0117 ,,	O = 1·00
II.	CuO = 0·1614 ,,	CuO = 2·90
	O = 0·0113 ,,	O = 1·00
III.	CuO = 0·0703 ,,	CuO = 2·4
	O = 0·0059 ,,	O = 1·00

To what the irregularities in the results were due I am unable to say. The action of the hypochlorite solution on the ferrous sulphate solution was the same when equal quantities were used. No hydrogen dioxide could be found in the acidified solutions, which could act on the iron irregularly and also on the permanganate, and no oxygen escaped on acidifying. I think it probable that a more extended trial of this method would yield satisfactory results.

I tried to use potassium iodide instead of ferrous sulphate, but with little promise of success, as the results varied greatly. I found it exceedingly difficult to obtain constant results with potassium iodide in determining cupric salts alone, except in very dilute solutions, so I abandoned this method as unreliable.

Of course it would be impossible to prove whether calcium was a constituent of this copper precipitate or not when made according to Crum's method, for the suspended calcium hydroxide settles down with the precipitate containing copper, and could not be separated. I found, however, that a large excess of lime-water could be substituted for the suspended calcium hydroxide. By filtering the cold calcium hypochlorite solution carefully into a large flask provided with a rubber stopper, with two holes, through one of which the funnel passed, and through the other a tube filled with broken stick potash to exclude carbonic acid, and then running in about 1 litre of cold lime-water, and adding the copper nitrate solution, the copper hydroxide, which first precipitated, in four or five minutes went into a perfectly clear solution of a deep blue colour. This solution soon changed to a green, and then became nearly black, and from this a precipitate began to separate which had a crimson colour by transmitted light, and appeared exactly like the precipitate obtained with barium hypochlorite instead of calcium, to be described beyond. In a few minutes this precipitate began to evolve oxygen, and was converted into a heavy flocculent black precipitate.

Oxygen continued to be evolved for some hours, and the precipitate was kept floating on the surface. After standing twenty-four hours on ice it had settled. A portion of the solution containing this precipitate was drawn off and washed with lime-water. Under the microscope this precipitate appeared perfectly homogeneous and with a decided pink tint. The oxygen was determined with ferrous sulphate in 50 c.c. of the solution containing the precipitate as before described, and likewise the copper and the calcium. Fifty c.c. of the clear solution were drawn off and found to be free from copper, and the calcium determined. By subtracting the calcium found in the solution from that found in the solution plus the precipitate, the calcium of the precipitate was found. The error due to the amount of the solution displaced by the precipitate was too small to make any serious difference in the results.

In this way I found—

In sol. + precipitate.	Solution alone.
CuO = 0·1869 grm.	None.
CaO = 0·1798 ,,	0·1104 grm.
O = 0·0108 ,,	None.

	Weight.	Precipitate. Weight.	Ratio.
CaO in p.p. + sol.	0·1798	CuO = 0·1869	= 23·54
CaO in sol.	0·1104	CaO = 0·0694	= 12·39
CaO in p.p.	0·0694	O = 0·0108	= 0·0675

The oxygen found in this case is much lower than in the other analyses given, but from the wide variations in the former results its determination cannot be considered more than a qualitative test. The calcium, it will be seen, is in nearly a ratio of two atoms of copper to one of calcium, but I consider this single analysis by no means evidence of anything more than the *presence* of calcium in the compound, and is, so far as I can find, the only direct evidence that copper ever acts as an acid.

The rest of the precipitate from which this sample was taken for analysis was allowed to stand a week packed in ice. It grew gradually more and more dense, and of a brighter pink, until finally it was of a very brilliant rose-red, and formed in places on the sides of the flask very thin layers of a dazzling crimson. In the hope of being able to analyse this as Krüss did the dioxide of copper, I arranged a filter packed in ice and covered with a bell-jar communicating with the air through potash tubes, so as to keep out all carbonic acid, but before I could wash the precipitate it began to turn blue next to the paper. The middle portions were dried in the cold over sulphuric acid and remained quite pink when dry ; but the decomposition had extended so far, I abandoned the analysis, intending to try again, but have not since had time. Unfortunately lack of time prevented me from working further in this direction, and I give my results in hope that they may be of service to others in following up this subject, and settling beyond a doubt the composition of this interesting compound.

When barium hypochlorite in alkaline solutions is allowed to act on copper salts in the cold, a crimson-red precipitate is formed, which somewhat resembles the calcium cuprate just described, but in many respects appears different. But little seems to be known of this compound, it having been supposed to be either a higher oxide of copper, the same as the precipitate obtained with calcium, or else a corresponding barium salt. In hope of being able to analyse this red precipitate, I obtained results which I am entirely unable to account for, and publish them in the hope that someone may be tempted to investigate further and reach a satisfactory conclusion.

In order to make the red precipitate I found it best to put about 50 c.c. of strong baryta water, cooled to about 5° C., in a small flask, add 0·2 grm. of copper as nitrate or chloride, and then to pass chlorine gas through the solution till the colour changed to a blackish green, then to add 100 c.c. of baryta water of 5° C., and after shaking vigorously let stand about half an hour. The precipitate which forms on adding the 100 c.c. of baryta water changes from a blackish green to a dark dirty red, and then slowly to a bright crimson. This precipitate settles very slowly and evolves a gas gradually, and even when kept cold will decompose on standing a few hours. All my attempts to wash it failed utterly. On a filter-paper it decomposed rapidly. When washed with cold baryta water, by decantation, no apparent change beyond the very slow evolution of gas could be seen until several times decanted, when suddenly the crimson colour would disappear and a dirty pinkish precipitate remain. I had to abandon my attempts at decanting more than once or twice, and endeavoured to determine the composition of the precipitate by decanting once, letting the precipitate settle, and then drawing off 50 c.c. of the clear solution

and 50 c.c. of the solution containing the precipitate, and analysing each, the difference representing the precipitate.

No. 1.

	Precip. + sol.	Sol.	Diff. = p.p.
I. CuO	= 0·2905	—	= 0·2905
BaO	0·6965	0·6669	0·0296
O	0·0269	0·0267	0·0002
Cl	0·0268	0·0245	0·0023
II. CuO	0·3422	—	0·3422
BaO	0·7025	0·6657	0·0368

No. 2.

I. CuO	= 0·3035	—	= 0·3035
BaO	1·0754	1·0222	0·0532
O	0·0242	0·0240	0·0002
II. CuO	0·3127	—	0·3127
BaO	1·0837	1·0197	0·0640

No. 3.

I. CuO	= 0·2603	—	= 0·2603
BaO	0·5698	0·5577	0·0121
O	0·0082	0·0072	0·0010
Cl	0·0142	0·0118	0·0024
II. CuO	0·1918	—	0·1918
BaO	0·5627	0·5577	0·0050
O	0·0082	0·0064	0·0018

The above analyses show a small amount of barium in the precipitates, compared with the copper, which varies greatly with the different preparations and considerably in the different samples of the same preparation, while duplicate determinations in the solutions agree quite closely. A little chlorine was also present, but it seems more probable that the barium and chlorine were carried down with the precipitate as barium chloride than that they were united with the copper. The results show a fair average of a very large number of determinations of oxygen in various preparations. While with the calcium-copper precipitates I never failed to get an oxidation of the ferrous sulphate or chloride, with the barium-copper precipitates I never got an oxidation greater than in No. 3, II. It is evident that we have here two different compounds, but what the barium precipitate can be I cannot even suggest. I could get no evidence of an excess of oxygen in it in any way. Iodised starch-paper was unchanged when placed near the precipitate moistened with hydrochloric acid; whereas chlorine was freely evolved when the calcium cuprate was thus treated. When treated with sulphuric acid there was no evolution of oxygen, while with the calcium cuprate there was always a lively evolution of gas. When strontium was substituted for barium the same changes of colour took place, excepting a darker, duller, red precipitate was formed. It was necessary to suspend finely-ground crystals of strontium hydroxide in the water on account of its slight solubility.

With barium, strontium, and calcium (when calcium hydroxide solution is used instead of suspended lime) the same changes of colour take place; but in the case of the calcium the red precipitate, which is the final state with the barium and strontium precipitates, is followed by a change to a bulky black precipitate which evolves oxygen for some time, and gradually settles in the solution and changes to a crystalline rose-red precipitate.

The probability of my being unable to continue this investigation, for some time at least, has induced me to publish these very incomplete results in the hope that the beginning I have made will be of use to others who may wish to follow the subject further.

Amines contained in Suint Waters.—A. Buisine.—The mixture examined by the author contained, in 100 parts of total bases, 95 of ammonia, 4 of monomethylamine, and 1 of trimethylamine.—*Comptes Rendus*, No. 19.

ON RED AND PURPLE CHLORIDE, BROMIDE AND IODIDE OF SILVER: ON HELIOCHROMY AND ON THE LATENT PHOTOGRAPHIC IMAGE.*

By M. CAREY LEA, Philadelphia.

(Continued rom p. 257.)

Photochloride by Action of Alkaline Hypochlorites.

Black or purple-black chloride is easily obtained by the action of an alkaline hypochlorite on finely divided silver such as obtained by reduction in the wet way. Commercial sodium hypochlorite may be used to act on it. It is to be poured over the silver, and after standing a few minutes is to be replaced with fresh. After an hour or two this is again to be replaced with a new portion, which is to be allowed to act half an hour to insure the total conversion of the silver. The product varies somewhat in colour, is sometimes black, oftener purple-black. If the treatment with hypochlorite has been thorough, strong cold nitric acid of 1·36 sp. gr. extracts from it no silver. This reaction with nitric acid is important, as it shows that not only metallic silver was not present, but that the product contained absolutely no uncombined sub-chloride. For if any were present it would instantly be decomposed by the acid, in which one-half of its silver would dissolve. The action therefore appears to take place in this way. First sub-chloride is formed; part of this is further chlorised into normal chloride which at once combines with other sub-chloride, thus taking it out of the further immediate action of the hypochlorite, and this goes on until an equilibrium is reached and neither metallic silver nor uncombined sub-chloride is left, as is proved by the action of nitric acid. Alkaline hypochlorite, as will presently be shown, attacks uncombined sub-chloride very rapidly, the combined very slowly; by many days' contact the quantity of combined sub-chloride is gradually reduced.

Prolonged treatment with hot strong nitric acid destroys all the varieties of photo-chloride. The time needed varies a good deal. A specimen of that obtained with hypochlorite required twenty-five hours' heating with acid of 1·36 in a water-bath at 212° F. to bring it to the condition of white normal chloride. Considering that cold dilute nitric acid instantly destroys freshly precipitated argentous chloride in the free state, this long resistance to strong acid at the temperature of boiling water must be considered most remarkable.

When the red or photo-chloride is formed with the aid of a ferrous salt or ferrous oxide, I prefer to boil the product with dilute HCl to get rid of the last traces of iron, after a preliminary treatment with hot dilute nitric acid has removed silver and uncombined sub-chloride. The photo-chloride will sometimes even resist boiling aqua regia for a time.

Protected from light, photo-chloride is perfectly stable. Specimens obtained eighteen months ago appear to be quite unchanged.

When treated with ammonia, it is far more slowly attacked than the normal. The ammonia dissolves the normal chloride only. The union between the two must therefore be broken up, and this takes place slowly. The first action of the ammonia is to change the red or purple colour to greenish black and then to slowly dissolve out silver chloride. Hours are required even with a large excess of ammonia. Whilst this is going on, if the ammonia is poured off and replaced with nitric acid, the original colour reappears. If the action is continued sufficiently long, silver only remains and dissolves readily in nitric acid. A little short of this, treatment with nitric acid leaves a black residue of dark chloride mixed with metallic silver; the dark chloride being insoluble in any acid has led to some strange mistakes in a similar reaction

* *Amer. Journ. of Science*, 3rd Series, vol. xxxiii., p. 349.

which occurs in treating with ammonia silver chloride that has been exposed to the light. Even a theory has been had recourse to of a "passive condition" of silver. This passive silver is simply black chloride.

A specimen of purple black chloride was treated with warm strong aqua regia until whitened by conversion of the sub-chloride to normal. By this treatment 2·563 grms. of photo-chloride gained 9 m.grms., indicating the presence of 2½ per cent of sub-chloride, or more exactly—

Sub-chloride	2·49
Normal chloride	97·51

This is not to be taken in any sense as representing a constant composition. The proportion of sub-chloride varies between certain limits, not only according to the method of preparation used but independently of it. Another specimen of black chloride formed with hypochlorite gave figures that indicated a content of less than half of one per cent of sub-chloride.

Photo-chloride by Reduction of Normal Chloride.

This is an excellent means of obtaining red chloride. The white chloride is to be dissolved in ammonia and ferrous sulphate added, producing an intensely black precipitate. After standing a minute, the mixture is to be treated with dilute sulphuric acid until it shows a strong acid reaction.

The precipitate is to be first well washed by decantation, then boiled first with dilute nitric, then after washing with dilute hydrochloric acid, which must of course be thoroughly washed out.

The product obtained in this way is often of singular beauty. It might easily be taken for metallic copper. Sometimes it is as rich and bright in colour as the copper obtained by electric deposition. Everyone knows the richness and brilliancy of that form of copper, and I have seen it fully equalled by this silver salt.

The beauty of the colour depends always on the thorough removal of any metallic silver that may be present, and still more on getting rid of every trace of iron. The boiling with dilute hydrochloric acid should be continued until, after thorough washing, a fresh treatment extracts no more and the acid remains colourless in presence of alkaline sulphocyanide.

Instead of an ammoniacal solution of silver chloride, we may make a solution of any other silver salt in ammonia and reduce it in the manner just described with ferrous sulphate. But in this case hydrochloric acid must be used instead of sulphuric after the reduction. This single reaction includes an almost endless variety of methods. The acid with which the silver was originally combined seems to be not without influence on the result; in some cases, for example, with arseniate and molybdate, the action of coloured light on the red chloride seems to be somewhat modified. Silver phosphate, on account of the ease with which it suffers reduction, is very well adapted for this treatment.

Photo-chloride by Partial Reduction of Oxide by Heat, and Treatment with HCl.

This method has the advantage of avoiding all admixture of foreign substances, the last traces of which are very hard to get rid of, and seem to exert an effect on the colour disproportionate to their quantity. Accordingly the photo-chloride obtained in this way is very beautiful, the shades are from pink to copper red, and a tint resembling burnt carmine.

Heat may be applied to the oxide in either of two ways, long continued heat at 212° F., or near it; or the change may be effected by roasting.

When slow heat is to be applied care must be taken that the oxide does not carbonate itself, which it easily does superficially; this is an objection because the carbonate, under these circumstances, yields white chloride with which the other becomes mixed. The air of a drying oven heated by a gas burner is especially bad in this respect. I have seen a surface of oxide form a coat of yellow carbonate in a few hours in this way. (Most oxide that has been kept some time will effervesce briskly with an acid.) The method is uncertain, sometimes giving strongly coloured products and sometimes pale pink.

The oxide may be roasted in a shallow flat-bottomed porcelain basis. With a very moderate heat it changes from brown to black. When this is thoroughly accomplished and before grey reduction sets in, the oxide is to be treated with HCl. If this be done in the basin itself after cooling and without disturbing the position of the oxide, a curious variety of tints will be noticeable, depending upon slight differences in the heat affecting different portions.

Silver Carbonate may be roasted in the same way as silver oxide, and yields a similar product. By heat its colour changes from yellow to black; it is probable that the carbonic acid is driven off at a lower temperature than that at which oxide is reduced to silver, and that with it escapes part of the oxygen. The residue is converted by HCl into deep red chloride.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

The following were amongst the principal objects of interest at the Royal Society *Conversazione* on Wednesday June 8th :—

Apparatus for Shooting Threads of Glass, Emerald, Quartz, &c.—Exhibited by Mr. C. V. Boys, A.R.S.M.

A thin rod of the material is fastened to the tail of an arrow and heated at the end by an oxyhydrogen flame. The trigger of a cross-bow is immediately pulled, and the arrow shot, when a thread of extreme fineness is drawn out. These threads are far finer than spun glass, and many are finer than spider lines. Threads of quartz are practically free from elastic fatigue, and are most suitable for the torsion threads of instruments of precision. Quartz can be drawn so fine that the thinnest parts are beyond the power of any possible microscope to define them.

Optical Experiments.—Exhibited by Prof. A.W. Rücker, F.R.S. :—

1. Colours of Soap Films Rotating under the Influence of an Air Current.

A jet of air is directed on to the film so as to form a vortex, the colours of which change as the film becomes thinner. This experiment is due to Sir David Brewster. Attention has been recently called to it by Lord Rayleigh, Sec. R.S.

2. Artificial Imitation of the Colours of the Setting Sun.

Light is passed through a glass cell containing a solution of sodium hyposulphite. If a little hydrochloric acid is added, the sulphur is deposited in fine particles which scatter the blue end of the spectrum. The transmitted light becomes redder, and colours like those of sunset are produced. This experiment is due to Captain Abney, F.R.S.

3. Apparatus to illustrate the Passage of Light through Lenses.

An application on a large scale of the method of tracing the rays by passing them through air in a close space charged with a small quantity of smoke.

Some of Dr. J. Puluj's Vacuum Tubes, made by Müller, of Bonn.—Exhibited by Mr. Warren de la Rue, F.R.S., and Dr. Hugo Müller, F.R.S.

(1) Electrical radiometer with phosphorescent vanes.

(2) Electrical radiometer with phosphorescent rotating disc.

(3) Electrical radiometer with two phosphorescent rotating discs.
(4) Electrical radiometer with rotating bell glass.
(5) Phosphorescent lamp.

Electric Irradiation of Precious Stones, Minerals, and Rare Earths in Radiant Matter Tubes. — Exhibited by Mr. WILLIAM CROOKES, F.R.S., Pres. C.S.

A large induction-coil, containing about 60 miles of secondary wire, and capable of giving a 24-inch spark, is used to produce phosphorescence of the contents of the highly exhausted Tubes.

The Great Yellow Diamond from South Africa. Weight 116 carats. Fluorescent.—Lent by Mr. Streeter.

Fluorescent Diamond (Indian).— Phosphoresces yellowish grren.

Cape Diamonds.—Phosphoresce blue.

Brazilian Diamonds.—Phosphoresce red, orange, blue, and yellow.

Australian Diamonds.—Phosphoresce yellow, blue, and green.

Large Ruby from the Burmah Mines; Clusters of Uncut Rubies from Burmah; Cut Rubies Mounted; Artificial Rubies.—Phosphoresce of a brilliant crimson.

Topaz.—Phosphoresces blue.

Sapphire.—Phosphoresces green.

Spinel.—Phosphoresces with a crimson light.

Phenakite.—Usually phosphoresces blue. Occasionally a crystal is found which phosphoresces yellow.

Pectolite.—Phosphoresces of a straw colour.

Calcite.—Phosphoresces of an orange colour.

Phosphorescent Calcite from Branchville, S. Carolina.—When heated in air it has the curious property of glowing strongly with a golden yellow light. In the Radiant Matter Tube this phosphorescence is very brilliant.

Spodumene.—Phosphoresces of a yellow colour. A phosphorescing crystal of Spodumene has all the internal light cut off with a Nicol prism when the long axes of the Nicol and the crystal are parallel.

Dolomite.—A granular form from Utah; when scratched with a knife or struck with a pick it emits so strong a phosphorescent red light that the miners call it Hell-fire Rock. In the Radiant Matter Tube it glows with a fine red light.

Aluminium Oxide, Calcined.—Phosphoresces with a rich crimson light.

Zirconium Oxide, Calcined.— Phosphoresces with a bluish white light.

Strontium Oxide, Calcined.—Phosphoresces with a fine blue light.

Glucinum Oxide, Calcined.—Phosphoresces with a faint blue light.

Calcium Sulphide.—Phosphoresces blue, yellow, green, or red, according to the mode of preparation.

Yttrium Sulphate.—Phosphoresces with a golden yellow light. Examined with a spectroscope gives a remarkable discontinuous spectrum.

Samarium and Calcium Sulphate.—Phosphoresces with a red light, and gives a spectrum composed of three broad bands.

Apparatus illustrating the Supposed "New Force" of M. J. Thore.

Exhibited by Prof. J. NORMAN LOCKYER, F.R.S.:—

1. Experiments showing the difference between Line and Fluted Spectra.

A mixture of salts of sodium, lithium, and thallium, raised to incandescence in the flame of a Bunsen's burner, furnishes a convenient example of a line spectrum, the spectrum in this case consisting of a double yellow, a red, and a green line.

Carbon compounds, enclosed in so-called vacuum tubes, and raised to incandescence by a succession of sparks from an induction coil, give us very beautiful sets of flutings shading off towards the violet. The gases enclosed in the tubes are carbon monoxide and benzine. The tubes were filled in the usual way by connecting one end with a Sprengel's air-pump and the other with an apparatus for generating the gas or vapour, all joints, stopcocks, &c., being rendered air-tight by mercury joints. When the gas was pure and at a convenient pressure, the tube was sealed off with a blowpipe. In sealed tubes of this kind, variations of temperature can usually only be obiained by the use of a Leyden jar or jar and air-break; but in laboratory experiments, where the tube is left in connection with the air-pump, temperature can also be varied by changes in pressure. In tubes of the form exhibited, however, considerable variation can also be obtained by changing the length of the spark, and by using the capillary or wide part of the tube, as the case may be. It will be observed that, at different temperatures, different sets of flutings of carbon make their appearance.

2. Photographs showing Line and Fluted Spectra.

The fluted spectrum exhibited is one of the sets of carbon flutings which occurs in the spectrum of the electric ark.

The line spectra are the spectra of various metals, the metals or their salts being raised to incandescence in the electric arc, and their spectra photographed.

Exhibited by Prof. JOHN M. THOMSON:—

1. Experiments with Coated Crystals in different Solutions.

These illustrate (*a*) the production of substances not usually obtained artificially in the crystalline condition; (*c*) the formation of crystals through narrow orifices or cracks; (*d*) the probable manner in which certain natural crystalline minerals are formed.

1. Silver dichromate growing from potassium dichromate, coated with paraffin, suspended in silver nitrate.

2. Lead chromate from coated potassium dichromate in lead nitrate.

2. Experiments with Supersaturated Solutions.

(*a*) Tubes containing solutions of heteromorphous salts (sodium acetate and thiosulphate). Either of these solutions may be solidified independently of the other by dropping in a crystal of the particular salt in solution.

(*b*) Flasks containing different supersaturated solutions for experimenting with.

CHEMICAL SOCIETY.

Ordinary Meeting, June 2nd, 1887.

Mr. WILLIAM CROOKES, F.R.S., President, in the Chair.

THE PRESIDENT announced that the Council had resolved to present an Address of Congratulation to the Queen.

Certificates were read for the first time in favour of Messrs. William Elborne, Owens College, Manchester; and Herbert B. Stocks, 13, Peet Street, Liverpool.

The following papers were read:—

51. "*The Equivalent of Zinc.*" By Lieut.-Colonel REYNOLDS, late R.E., and Prof. W. RAMSAY.

The determination has been made by measuring the hydrogen evolved on dissolving zinc in acid, every precaution being taken to ensure accuracy; the weight of the hydrogen obtained was deduced from Regnault's determination of the density of hydrogen. The zinc used was separated by electrolysis from zinc sulphate, purified to the utmost possible extent; the last sample prepared was so nearly pure that dilute acid would scarcely act on it.

In all twenty-nine experiments were made. Four experiments had to be rejected; nine were not fully

corrected, and therefore were also rejected; the next eleven were considered preliminary, the mean atomic weight deduced from them being being 65·2430; finally, five experiments were completed, and the following results obtained from these are free from all known sources of error:—

65·5060
65·4766
65·4450
65·5522
65·4141

Mean .. 65·4787 ± 0·016135

Full details are given in the paper.

52. "*The Magnetic Rotation produced by Chloral, Chloral Hydrate, and Hydrated Aldehyde.*" By W. H. Perkin, Ph.D., F.R.S.

The author has shown in a previous paper (*Chem. Soc. Tr.*, 1886, 777) that when water unites with another substance so as to produce an atomic and not a molecular compound, the magnetic rotatory power of the product is less than the sum of the magnetic rotatory powers of the compounds used in its formation. He has now applied the same method of examination to aldehyde and chloral and their hydrates.

Chloral hydrate was examined (*a*) in the fused state at 55·5°; and at the ordinary temperature (*b*) dissolved in water in the proportion of 1 mol. to 3 mols. of water, and (*c*) dissolved in a new neutral liquid isoamyl oxide. Deducting from the values found that deduced for liquid chloral, the results are as follows:—

	Fused at 55·5°.	In water.	In amyl oxide
Chloral hydrate ..	7·173	7·016	7·028
Chloral	6·590	6·590	6·590
	0·583	0·426	0·438

From these numbers it is evident that chloral hydrate does not contain water as a constituent, as in that case the difference should be 1·00.

As ethylidene glycol, $CH_3{\cdot}CH(OH)_2$, is not known at any rate in a pure state, its magnetic rotatory power was deduced from that of some of its derivatives (*Chem. Soc. Trans.*, 1884, 571). Deducting from the most probable value (2·817) that of aldehyde (2·385), a difference results (0·432) which is practically identical with those found in the case of chloral hydrate at low temperatures. The result obtained with fused chloral hydrate at 55·5° is a little higher, but there is no doubt that the hydrate is slightly dissociated when heated to this temperature: that this is the case is further indicated by a series of determinations of the density of a solution of chloral hydrate in amyl oxide between 4° and 60°, a change in the curve obtained on plotting the results being seen to occur at a point corresponding to a temperature a good deal below 55·5°.

Experiments were also made with mixtures of aldehyde and water, that generally used consisting of equimolecular proportions. On making this mixture of aldehyde and water some interesting peculiarities were noticed. If the temperature of the air and of the liquids be about 8° or 9°, at the moment of mixing the temperature drops about 1·5°; it then commences to rise somewhat quickly, and continues to rise, but more and more slowly, for a long time: in one experiment, made in a large test-tube covered with cotton-wool, commencing at 9° the temperature rose to 18·7° but only in the course of twenty-five minutes. If the temperature of the substances before admixture be about 16°, and the quantities not too small, the rise of temperature is more rapid and the mixture enters into ebullition.

On attempting to determine the density of the mixture of aldehyde and water, the results obtained were at first very perplexing, from the fact that concordant numbers could not be obtained. It was then found that when any change of temperature took place the volume did not become constant in less than two and a half to three hours, so that in determining the density it was necessary to keep the tube containing the mixture at the desired temperature for two and a half hours before adjusting. Part of the product evidently undergoes dissociation as the temperature rises, re-combination taking place as the temperature falls, but only very gradually, a small variation of temperature sufficing to produce a disturbance.

Comparing the magnetic rotatory power of aldehyde with that of the mixture with water at 16°, the difference 0·929 = 3·324 − 2·385 is less than 1·00, and it may therefore be concluded that combination takes place; at a lower temperature no doubt this combination would have been found to be more perfect. There can, however, be no doubt that ethylidene glycol is present in the mixture.

Glycols are viscid fluids, and it is interesting to notice that when the hydrated aldehyde is shaken up, a froth forms which does not break at once, the mixture differing in this respect from aldehyde and also from water.

The effect of mixing aldehyde and absolute alcohol in molecular proportions is also very interesting. If the temperature of the liquids be not too low, the temperature rapidly rises and the mixture boils; if, however, the temperature be low, say 8° or 10°, the temperature immediately falls seven or more degrees; the rise then sets in, and before long the mixture reaches its boiling-point. In the first instance the fall is due to what may be called molecular arrangement setting in between the two fluids, which is a physical change and occurs before chemical action has had time to take place to any appreciable extent; then chemical action takes place more and more rapidly, and in consequence the temperature rises.

On mixing pure dry ether with aldehyde a fall of temperature occurs; subsequently the temperature rises gradually, but only to that of the surrounding air.

53. "*Note on a New Class of Voltaic Combinations in which Oxidisable Metals are replaced by Alterable Solutions.*" By C. R. Alder Wright and C. Thompson.

It appeared to the authors probable that just as a liquid capable of parting with oxygen, chlorine, &c., can be used in conjunction with an electrode of unchangeable material at one side of a voltaic cell (as in Grove's nitric acid battery and analogous combinations), or may be replaced by a solid conducting electrode, itself capable of losing oxygen (*e.g.*, a plate of strongly compressed peroxide of lead), so conversely might a conducting plate of oxidisable material (*e.g.*, zinc) at the other side be replaced by an unchangeable electrode in conjunction with a liquid capable of taking up oxygen, chlorine, &c., without producing any fundamental change in the character of the actions taking place in the cell whilst generating a current. The electrode immersed in this oxidisable substance, like the zinc of an ordinary cell, would acquire the lower potential, and the opposed plate the higher potential; *i.e.*, the wire connected with the latter would be the "positive pole" of the construction in reference to the external circuit.

On trial it has been found that such is the case, and that in consequence a large variety of novel forms of cell becomes easy of construction. For example, sodium sulphite or potassium ferrocyanide solution opposed to chromic-sulphuric acid solution; preferably with an intermediate layer of some neutral salt solution, such as sodium sulphate, to prevent the direct action of the two fluids on one another. During the passage of a current sodium sulphate or potassium ferricyanide is formed in quantity proportionate to the electricity passing, *i.e.*, to the amount of silver thrown down in a silver voltameter included in the circuit, whilst chromium sulphate is produced at the other side. Various analogous cells are described, in particular one where lead oxide dissolved in caustic soda is opposed to alkaline hypobromite: in this case lead dioxide is produced and separates out in the solid form; and one where chromium sesquioxide dissolved in caustic soda is opposed to chromium trioxide dissolved

in sulphuric acid; here sodium chromate and chromium sulphate are formed, an E.M.F. about equal to that of a Daniell cell being set up.

DISCUSSION.

Mr. PAGE said that after listening to Dr. Wright he was able for the first time to understand how electric currents might arise in the animal body.

Dr. ALDER WRIGHT said in reply to Mr. Page that the experiment suggested of opposing venous and arterial blood had not been actually tried by him as yet, but he thought it quite probable that a weak current might be produced (the PRESIDENT subsequently said that he had been told—he believed by Mr. Peter Squire—that a current was produced on opposing venous and arterial blood). By opposing alkaline pyrogallol solution to oxidising agents, notable currents could be developed; and various other organic compounds might be used instead of pyrogallol. With certain organic bodies, however (*e.g.*, chloral hydrate), attempts to produce oxidation in cells had hitherto failed. The opposition of acid and alkaline fluids alone would not necessarily produce more than infinitesimal currents; Becquerel's "*pile à oxygène*" (nitric acid opposed to caustic potash solution) gave rise to decomposition of nitric acid and evolution of oxygen from the electrode immersed in the alkali; other authors had found that analogous cells with chromic-sulphuric acid instead of nitric acid would behave in the same way and develop a continuous current capable of doing external electrolytic work, such as deposition of silver in a voltameter; on the other hand, a cell in which caustic soda and sulphuric acid only were opposed (so that chemical action other than neutralisation could not take place) would only develop an infinitesimal current through a silver voltameter, capable of depositing only traces of silver even after some days, although its E.M.F. measured by an electrometer was considerable.

With regard to the observations of Dr. Armstrong, he would say that while without doubt Grove's gas battery was the prototype of the class of cells discussed, inasmuch as that combination was virtually an oxidisable solution of hydrogen opposed to an oxidising solution of free oxygen, still the examination of cells in which other oxidisable fluids were used instead of hydrogen solution, and other oxidising substances besides solution of oxygen, was a branch of experiment in which hardly anything had hitherto been done, and which seemed to merit some little attention. The authors desired to study in detail the general behaviour of certain typical classes of cells in which actions of the kind take place, especially from the point of view of elucidating the precise chemical changes going on and their relations to the amounts of electrical (or current) energy developed. Whilst there was not exactly a probability of any very startling discovery being made, there were still a number of points of interest connected with the subject worth examining; and although the hope of an improved primary battery based on actions of this kind for commercial use, as suggested by the President, was perhaps not yet within measurable distance, yet the problem of economically obtaining current energy by direct chemical action (and especially by oxidation) was one now attracting considerable attention, and it was impossible to predict what might or might not be the result of systematic experiments tending in that direction. The importance of obtaining practically usable currents from coal direct without the use of the steam engine and dynamo could hardly be over-rated should it hereafter be found practicable so to do; and in view of the compactness of the animal machinery, whereby the oxidation of fuel in the form of food gave rise by muscular action to mechanical energy, it did not seem to be of necessity hopeless to attempt to solve such a problem.

54. "*The Composition of Prussian Blue and Turnbull's Blue.*" By EDGAR F. REYNOLDS.

According to Williamson, these componnds are respectively represented by the formulæ Fe_7Cy_{18} and Fe_5Cy_{12}, but Reindel and others have conjectured that they are identical in composition. The author has carefully prepared Prussian blue from hydrogen ferrocyanide and ferric chloride, and Turnbull's blue from hydrogen ferricyanide and ferrous sulphate; his analyses of the products show that Williamson's formulæ are correct expressions of their composition.

55. "*Phlorizin.*" By Professor E. H. RENNIE, D.Sc.

The author has endeavoured by a re-examination of phlorizin to decide as to the correctness or otherwise of the usual formula, and also to ascertain whether the sugar yielded by it on hydrolysis is really dextrose or not. He shows by analyses and by a quantitative examination of the decomposition by dilute sulphuric acid that the usualty accepted formula and equation correctly describe the composition and hydrolysis of phlorizin. The sugar obtained from it melted at 85° to 86°; its molecular rotatory power was $[\alpha]_D = 57{\cdot}9°$; and it gave with phenylhydrazine hydrochloride a yellow crystalline precipitate melting at 204 to 205°: there can be little doubt, therefore, that it is ordinary dextrose.

56. "*Further Notes on the Chemical Action of Bacterium Aceti.*" By ADRIAN J. BROWN.

The author has continued his studies on the oxidising actions of *B. aceti*, and states that although mannitol has been shown to be easily converted into lævulose by the organism, its isomeride, dulcitol, is not acted upon.

The dihydric alcohol, glycol, is oxidised into glycollic acid, no further product being formed. The action is carried on much further when calcic carbonate is present to neutralise the acid as it is formed.

The trihydric alcohol, glycerol, is found to be completely decomposed into carbon dioxide and water, the only other product formed being a very small amount of an acid the identity of which could not be determined. Glycerol appears to encourage the growth of *B. aceti* more than any other substance with which the author has experimented.

The tetrahydric alcohol, erythrol, resists the action of the organism. Attention is called to the fact that erythrol and methylic alcohol are both acted on by oxygen in presence of platinum-black, but escape oxidation when placed under the influence of *B. aceti*; it is also shown that when the same substance is submitted to oxidation in the two ways, the products are generally dissimilar, as in the cases of mannitol and dextrose. It is therefore considered that although the products of the actions which occur in presence of both platinum-black and *B. aceti* are similar in the case of ethylic alcohol, the manner in which the oxidation is effected, contrary to the usual idea, is probably quite different.

Mannitol has been prepared by the author from pure dextrose by the action of sodium amalgam. On submitting this to the action of *B. aceti* it was converted into lævulose, thus completing the conversion of dextrose into lævulose. As the melting point and crystalline form of mannitol from dextrose are similar to those of mannitol from manna, there can be little doubt that the two mannitols are identical.

57. "*Note on the Cellulose formed by Bacterium xylinum.*" By ADRIAN J. BROWN.

The author showed in a previous paper (*Chem. Soc. Trans.*, 1886, 432), that an acetic ferment, *B. xylinum*, is able to convert lævulose into cellulose. On treating this cellulose with strong sulphuric acid, it is found to be converted into a dextrorotary sugar, and in this respect to resemble ordinary cellulose.

58. "*The Oxidation of Ethyl Alcohol in the Presence of Turpentine.*" By C. E. STEEDMAN, Williamstown, Victoria.

The author finds that dilute ethyl alcohol in the presence of air and turpentine becomes oxidised to acetic acid. The experiment was made by placing in a clear glass 16-oz. bottle a mixture of 2 drams of alcohol, 1 dram of turpentine, and 1 oz. of water; the bottle was securely corked and left exposed to a varying temperature averaging about

80° F. for three months; at the end of that time the liquid was strongly acid from the presence of acetic acid.

One curious fact appears to have light thrown upon it by this observation. Mr. McAlpine, Professor of Biology at Ormond College, Melbourne University, has a method of preserving biological specimens by abstracting their moisture with alcohol after hardening in chromic acid, and then placing the specimen in turpentine for some time; great discrepancies arise, however, according as the alcohol is allowed or not to evaporate from the specimen before dipping it into turpentine.

At the next Meeting on June 16th there will be a ballot for the election of Fellows, and a list of the Papers to be read is given at p. 272.

NOTICES OF BOOKS.

Nitrate of Soda: its Importance and Use as Manure, By A. STUTZER, Ph.D. Edited by Prof. P. WAGNER. Ph.D. London: Whitaker and Co. 1887.

NITROGEN is one of the most important elements on which plants depend for their sustenance: it is as necessary to their existence as light or rain; it is found in the roots, leaves, seed, and wood, and is also an element in the formation of *protein*, to produce which is the principal object of agriculture. In his essay on this subject, under the above title, Mr. Stutzer has carefully reasoned and discussed the question as to how nitrogen should be best applied. Farmyard manure is in very few cases sufficiently rich to supply the necessary quantity, and recourse must be had to other sources. It has been proved that plants cannot thrive unless nitrogen is supplied to the roots. In the experiments of Lawes and Gilbert crops were obtained from the same plot of land for more than twenty-five years without the addition of any nitrogen in the form of manure, and it has been equally shown that nitrogen is not absorbed by the plant from the air; hence in this case the ammonia and other nitrogenous matter in the air must have been carried down by the rain into the soil, and so reached the roots.

The principal artificial nitrogenous manures are nitrate of soda, sulphate of ammonia, and animal refuse. The first is the most important, and its exportation from South America has been increasing enormously during the last fifty years.

In the chapter on the supposed exhaustion of the soil, following the use of nitrate of soda, it is pointed out that the alleged deterioration is caused simply by the increased crop having absorbed more potash and phosphoric acid than an ordinary or poor crop would have done. The crop itself does not contain a larger percentage of these two substances, but the soil is exhausted simply in proportion to the increase of the crop.

It is of course well known that manure best suitable to one plant cannot be so advantageously employed with another. To show the varying effects of nitrate of soda Mr. Stutzer has given the results of a number of trials in tabular form, and we find that the increase in value of different crops varies from 11 in the case of hay to 35 in the case of potatoes.

This is an important subject, but one which has not yet been properly considered: it, however, resolves itself into finding what is the receptive power of plants for this manure.

The second part of this pamphlet considers the question of how nitrate of soda can best be used as a manure as regards mixture with other manures, quantities required, time of application, and the requirements of different crops, plants, and trees.

The Appendix gives a series of tables containing the results of the trials and experiments above referred to.

To all who are concerned in agriculture, either experimentally or as a business, this book will be of great interest, and we doubt not of real service. The recommendations and hints given are to be relied on as the outcome of careful investigation and a thorough knowledge of the subject.

England as a Petroleum Power, or the Petroleum Fields of the British Empire. By CHARLES MARVIN. London: R. Anderson and Co. 1887.

THE petroleum industry of the world is one which is yearly assuming more and more importance: its influence has already been felt in a serious manner by those engaged in the palm- and whale-oil trades, and in another ten years it may make a complete revolution in the generation of steam, especially on steamboats, and thus affect the coal industry.

The great Russian oil-wells at Baku afford a striking example of what can be done by capital and engineering skill combined. Ten years ago these wells were quite undeveloped, and even at the end of the Turkish war in 1878—when the Nobles were taking up the question of working them scientifically—the European petroleum world was ignorant of their existence. Now the export has reached 115 million gallons yearly.

The kingdom of Burmah, recently annexed by England, contains petroleum fields equalling, if not exceeding, in richness any others in the world. They have been worked in a dilatory kind of way for centuries: 100 years ago there were 500 wells in operation, producing more than 90,000 tons of oil annually. During the reign of King Theebaw all manners of restrictions were placed on the trade, and excessive royalties were exacted: this, combined with the competition of the American oil fields, has had a most depressing effect, and the annual production has sunk to little over 10,000 tons. English enterprise ought not to allow this state of depression to exist, in view of the enormous importance petroleum will be to the Empire in the near future. We are, however, fortunately situated, for, besides the Burmese oil fields, we have petroleum occurring in India, in districts where there is no coal; we have, again, large deposits of shale in England stretching from the Eastern Counties right up into Scotland, and vast supplies have been discovered in New South Wales, yielding twice as much oil as that found in Scotland; so it may be assumed that our prospects as a petroleum power are excellent; but the matter must not be allowed to rest, other nations are attacking the subject vigorously, and England must show that she can still hold her own in any new industry, wherever it may be situated.

CORRESPONDENCE.

DEPOSITS OF PHOSPHATE IN ITALY.

To the Editor of the Chemical News.

SIR,—I have been very well pleased in perusing the article on the above subject by Mr. Konrad Walter (CHEMICAL NEWS, vol. lv., p. 229), and I need hardly say that I agree with all that he says concerning the possibility of introducing chemical industries into Italy.

I quite agree with him also that, as far as chemical manufactures are concerned, my compatriots, especially of the South of Italy, have not sufficiently recognised the importance of utilising the rich mineral treasures which are found on the spot. The plain fact is that chemical manufacturing is scarcely as yet understood there, although there are a few bright examples here and there of enterprising spirit shown in that direction.

It has been my aim for years to see that new chemical industries should be started in Italy, and am therefore

very glad that Mr. Walter comes forward with his practical proposal of establishing the manufacture of superphosphates at Gallipoli, where sulphuric acid would also be produced, and I heartily hope he will induce some enterprising English capitalists to take the matter in hand.

As Gallipoli is situated on the sea-shore the proposed works would be well situated: there is, besides, the advantage for Englishmen of being near their favourite element, the sea. Gallipoli is also well known for its exportation of olive oil, and consequently for the numerous oil factories.

I had opportunity, about four years ago, to visit Taranto (the old *Tarentus* of the Magna Græcia of historical renown), in connection with an oil works for extracting oil from the expressed olive-seed by means of bisulphide of carbon, and was struck by the enterprising commercial spirit of the leading firms there, and was pleased to see works which had been put up and constructed on the best possible modern principles.

Considering the great cordiality existing between the English people and the Italians, I heartily hope that English chemical manufacturers will settle in Italy, where in many cases they will find an almost virgin soil, and be free from the keen competition and hard struggle for existence which is just now the order of the day in the great English chemical industry.—I am, &c.,

A. Sansone.

Vauxhall Chemical Works, Collyhurst, Manchester, May 31, 1887.

THE SUPPOSED "NEW FORCE."

To the Editor of the Chemical News.

Sir,—It might be well to place a cat in front of the apparatus. If the cylinder rotates then it will of course show that the supposed "new force" is not "inherent in the human organism."—I am, &c.,

G. A. Keyworth.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 19, May 9, 1887.

Researches on the Emission of Ammonia by Vegetable Mould.—MM. Berthelot and André.—The authors' results apply essentially to the cultivated clay soils of the neighbourhood of Paris. This soil emits spontaneously ammonia by reason of the slow decomposition of the amidic and ammoniacal compounds which it contains. This decomposition is effected at once under the influence of purely chemical actions due to water and earthy carbonates, and doubtless also under the influences of purely physiological actions due to fermentation, to microbia, and to vegetation properly speaking.

Probable Part played by Magnesia and other Bodies in the Resistance of French and American Vines to the Phylloxera.—A. C. Dejardin.—Magnesia forms a very important constituent in all soils in which the French vine resists, and in those where the American vine flourishes best. Its percentage in the ash of the American vine is more considerable than in the ash of *V. vinifera*. Practical experiments are needed on the use of magnesium-ammonium phosphate as a manure for vines.

Reversible Decomposition of the Acetates by Water.—G. Foussereau.—In former communications the author has studied, by means of the measurement of electric resistances, the reversible decompositions which many metallic chlorides slowly undergo in their solutions under a variety of influences. He has since observed analogous phenomena in iron and aluminium sulphates, in common alum, and in copper, zinc, and lead acetates. These last bodies present some remarkable peculiarities. If their solutions are kept for some time at 100°, or even at lower temperatures, they deposit a basic salt.

On Glyceric Aldehyd.—E. Grimaux.—According to Gorup-Besanez, mannite yields a glucose and mannitic acid under the influence of platinum black. The author has applied this process of oxidation to glycerin in order to obtain glyceric aldehyd. As this aldehyd possesses the same composition as glucose, and is at once a polyatomic alcohol and an aldehyd, it remained to be seen if it could be converted into a glucose capable of fermentaction, or if it could be fermented directly. The oxidation products of glycerin by platinum black were found capable of fermentation under the influence of beer-yeast. Carbonic acid is given off and alcohol is formed.

Synthetic Acetic Acid and its Derivatives.—Louis Henry.—The author has compared this synthetic acid with ordinary acetic acid, and finds them identical in all respects, both in their reactions and in their derivatives.

Action of Cyanamide on the Sulpho-conjugated Amidised Aromatic Acids.—J. Ville.—Sulphanilic acid forms, with cyanamide, an addition product, sulphanilocyamine, analogous to the creatines. This body does not give a dehydration-product corresponding to the creatinines, at least in the ordinary conditions of the formation of these bodies. The study of the isomers will show if this is a property common to the sulpho-conjugated amido acids, due to the acid function SO_3H, which does not lend itself to dehydration.

On Anemonine.—M. Hanriot.—The author assigns to this substance, which he obtains from *Anemone pulsatilla*, the formula $C_{15}H_{12}O_6$. Besides the portion soluble in alcohol, there remains an insoluble substance having apparently the same composition. Anemonine melts at 156°, and is decomposed at 270°. The author has obtained from it a hydrocarbon (a cumene or a cymene) and also a bromo-anemonine and a hydro-anemonine, the latter much more stable than anemonine itself.

Certain Derivatives of the Residues of Compressed Gas.—Albert Colson.—The author finds that the two hexabromides which he has prepared by setting out from erythrite can also be formed by the action of bromine upon synthetic erythrene tetrabromide.

On Butyl Sebate.— G. Gehring.— Butyl sebate is a colourless liquid of an agreeable and aromatic odour and a burning taste. It is insoluble in water, miscible in all proportions with alcohol, but less readily with ether. Its density at 0° is 0·9417. It boils, under ordinary pressure, at 344° to 345° without decomposition. A few drops placed on a glass rod burn with a very luminous flame, the nucleus of which is a splended deep blue. Strong sulphuric acid decomposes it, even in the cold. Caustic potassa saponifies it, and ammonia gives a white precipitate of sebamide in microscopic crystals.

Creatines and the Creatinines; Formation of α-amido-capro-cyamine and α-amido-capro-cyamidine. — E. Duvillier.— This paper does not admit of useful abridgment.

Determination of the Carotine contained in the Leaves of Plants.—A. Arnaud.—The quantity of carotine contained in leaves cannot be neglected. It borders upon 1·10ooth of the weight of the dried leaves, and the colour which it imparts modifies completely the tint due to chlorophyll.

Combination of Hæmatine with Nitric Oxide.—G. Linossier.—A solution of hæmatine reduced, or of oxyhæmatine in ammoniacal alcohol, absorbs nitrogen dioxide energetically, and becomes of a bright red, not dichroic. If examined with the spectroscope it presents, in place of

the well-known spectrum of hæmatine in an alkaline solution, a spectrum analogous to that of oxyazotised hæmoglobine.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Apparatus for Converting Nitrogen Tetroxide into Nitric Acid.—I wish to know a good form of apparatus for converting nitrogen tetroxide, obtained by heating a heavy metal nitrate, or by the action of water on nitro-sulphuric acid, into nitric acid. The nitrogen tetroxide would, of course, be passed into water, and the resulting nitric oxide be re-oxidised to the tetroxide by mixing with air, and again the tetroxide decomposed by water, and so on, till practically all the tetroxide was converted into nitric acid. M. Schloesing, in his method for preparing chlorine, decomposes manganese nitrate by heat, and converts the NO_2 obtained into nitric acid, re-obtaining about 90 per cent of the original nitric acid. Would you kindly say if there is a recognised form of apparatus for such a process on the large scale?—J. T.

MEETINGS FOR THE WEEK.

TUESDAY, 14th.—Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
WEDNESDAY, 15th.—Meteorological, 7.
THURSDAY, 16th.—Chemical Society, 8. Ballot for the election of Fellows. "The Thermal Constants of a Liquid Mixture," by Prof. W. Ramsay and S. Young. "Derivatives of Hydrindonaphthene and Tetrahydronaphthalene," by Dr. W. H. Perkin, Jun. "The Formation of Closed Carbon Chains in the Aromatic Series," by F. S. Kipping, B.Sc., and W. H. Perkin, Jun. "The Action of Ethylene Bromide on Ethylic Acetoacetate," by P. C. Freer, Ph.D., and W. H. Perkin, Jun. "Derivatives of Pentamethylene," by H. E. Colman, Ph.D., and W. H. Perkin, Jun. "Derivatives of Hexamethylene," by P. C. Freer, Ph.D., and W. H. Perkin, Jun. "An Attempt to Synthesise a Carbon Ring containing Seven Carbon Atoms," by P. C. Freer, Ph.D., and W. H. Perkin, Jun.
—— Royal, 4.30.

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TO MANUFACTURING CHEMISTS AND OTHERS.

THE METROPOLITAN BOARD OF WORKS will meet at the Office of the Board, Spring Gardens, S.W., on FRIDAY, the 17th day of June, 1887, at Twelve o'clock at noon precisely, and will then be prepared to OPEN TENDERS by parties who may be willing to contract for the supply of 1000 tons of Manganate of Soda and 1000 tons of Chloride of Lime (Bleaching Powder). Parties desirous to submit Tenders, for the whole or part of the foregoing quantities, may obtain a copy of the Specifications, form of Tender, and information as to the places and periods of delivery, on application to the Chemist of the Board, at the Office, Spring Gardens, between the hours of Nine a.m. and Four p.m. (on Saturdays between the hours of Nine a.m. and Two p.m.) until Thursday, the 16th day of June, 1887. The Tenders, which must be on the form supplied from this Office, and addressed to the Clerk of the Board, are to be delivered at the Office before Four o'clock on the last-mentioned day, and no Tender will be received after that hour. The Parties tendering must be in attendance at the Board at Twelve o'clock on the day appointed for opening Tenders, and any Tender which is not fully filled up in every particular will be rejected. The Board do not bind themselves to accept the lowest or any Tender.

Spring Gardens, S.W., 7th June, 1887. J. E. WAKEFIELD, Clerk of the Board.

TOTTENHAM LOCAL BOARD OF HEALTH.

PROTO-SULPHATE OF IRON or GREEN COPPERAS.

The Local Board invite Tenders for the Supply and Delivery at their Sewage Works, Page Green, Tottenham, of PROTO-SULPHATE OF IRON, to be delivered in Five Ton lots as and when required.—Tenders, stating full particulars, to be delivered to the undersigned on or before Wednesday, the 22nd instant. The Board will not be bound to accept the lowest or any Tender.

Dated this 10th day of June, 1887.
By order, EDWARD CROWNE,
Local Board Office, Tottenham, N. Clerk to the Board.

The MIDLAND RAILWAY COMPANY are prepared to receive offers for the purchase of the surplus Ammoniacal Liquor and Tar produced at their Gas Works at Derby and London (Brent) during twelve months ending June 30th, 1888.

Forms of Tender and particulars may be had on application to Mr. PETTIFOR, Midland Railway, Derby.

Tenders must be sent in on or before Thursday, the 30th of June, 1887.

The Company do not bind themselves to accept the highest or any Tender.

Derby, June 6, 1887. JAMES WILLIAMS, Secretary.

TIN OXIDE (Moist).—Wanted Address of Makers of this material.—Apply to "Tin Oxide," CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

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THE CHEMICAL NEWS.

Vol. LV. No. 1438.

HER MAJESTY'S JUBILEE.—A SCIENTIFIC RETROSPECT.

The Jubilee rejoicings upon which we are entering naturally lead us to indulge in a retrospective view of the progress of chemical science during the last half-century, and to survey its present position and its prospects. That position, we must admit, has its lights and its shades.

On the one hand all the facilities and appliances for scientific study are much more accessible and available than ever before. Of text-books, works of reference, and scientific journals there is a perfect plethora. Instruments of precision have been greatly improved, and, as far as practicable, reduced in price. Chemical teaching is winning its way even into schools of the most *arriére* character, and efficient laboratories are being equipped at our universities and technical colleges.

But on the other hand the examinational system is eating its way deeper and deeper into all our educational establishments, and is, by a process of *unnatural* selection, bringing to the front not the most original and creative minds, but those which most rapidly absorb the work of others. A still greater drawback is the political excitement which has prevailed increasingly for the last ten or eleven years, and which more and more draws off public attention from Science.

Nor can it be forgotten that many influential literary men, historians, novelists, poets, and ethicists look upon such studies as physics, chemistry, and biology with ill will. Hence we have little reason to fancy that discovery and invention have entered upon a golden age.

If we compare the respective positions of chemistry in 1837 and in the present year, we see at once strange resemblances and differences still more strange. Very much good work had, indeed, been done. The conception of matter as incapable alike of production or destruction by human agency, or under human experience, had been firmly grasped. The appeal to the balance was everywhere recognised. The notion of the elements as bodies incapable of decomposition or transmutation was held with little question. By far the greater number of these simple bodies—all, indeed, sufficiently abundant to be of practical importance—had been discovered and their atomic weights had been determined with a greater or less degree of accuracy.

As regards the combination of these elements dualism reigned supreme. Indeed, a thinker, who, though no chemist, is still recognised by a certain philosophic sect as the law-giver of all Science, declared, as lately as 1838, that it requires to be universally received in chemistry, and that even organic compounds may be reduced to a succession of binary combinations! The energy with which bodies tended to unite was supposed to depend on their respective distances from each other in the electro-chemical series.

In organic chemistry—as the chemistry of the carbon compounds was then called—the organic bases were being rationally studied. Not only had a number of the vegetable alkaloids been detected and characterised, but the first steps had been taken in the study of the so-called artificial bases, since so fruitful. Aniline had been discovered as far back as 1826 among the products of the destructive distillation of indigo, whilst chinoline was brought to light in 1834. The important hydrocarbon benzol had been recognised by Faraday. Above all, Wœhler, by his artificial preparation of urea, may be said to have effected the first true organic synthesis, and established the continuity of the organic with the inorganic.

We cannot say that in or about the year 1837 there took place any one epoch-making discovery, but the progress of research has become from decade to decade more rapid. The seeds sown in the earlier part of the century have sprung up and borne fruits sometimes not imagined by the sowers.

Turning now from the past to the present, one of the most important changes—not affecting chemistry alone—is that the several disciplines, though by no means losing their respective identities, are being brought into closer mutual relations. This is especially the case as regards chemistry and physics. There is a large and important territory common to both. We find ourselves unable to discuss fundamental questions concerning matter and energy, atoms and molecules, without making use of conceptions belonging to the one as to the other. The great modern doctrine of the conservation of energy—one of the grandest triumphs of the half-century—affects both in an almost equal degree. The law of Avogadro, once little regarded by chemists, now occupies a leading position in theoretical chemistry. No longer can it be said that "physics treats of masses acting at sensible distances, while chemistry treats of molecules acting at insensible distances." The two sciences, acting in concert, have developed a novel means of research, spectral analysis. The value of this method to the astronomer is of the greatest significance as overturning the Comtean dogma that the simpler sciences of his classification are independent of those more complex.

On the opposite frontier biology has undergone novel developments which cannot fail, sooner or later, to throw a new and welcome light upon chemical phenomena. The law of evolution, which has dimly loomed upon us through antiquity and the middle ages, has at last won general recognition, thanks to Darwin and Spencer, and must make itself felt in our science also. Again, the action of minute living beings is now recognised as effecting chemical compositions and decompositions, so that the chemist can no longer ignore biological considerations—a further blow at the Comtean dogma above referred to.

But narrowing our gaze, we must now glance at the growth of general and philosophical chemistry during the half-century just closing. One of the most familiar changes has been the fading away of the Berzelian electro-chemical theory of combination, with its necessary adjunct, dualism, and the recognition of direct multiple combination and of substitution. A little later has followed the attempt to assign to different atoms or groups of atoms forming a compound body, definite positions, and to express and record these positions, by means of structural formulæ. All this, together with the changes in nomenclature and notation involved, is still, for the present, known as the "new chemistry."

Great attention has been drawn to the numerous organic syntheses which have been effected. But, however important these results must appear in an industrial and technical point of view, they no longer present the same philosophical interest as does the first step in this direction taken by Wœhler. It is manifest that these discoveries could hardly have been made without a careful study of the relative position of the atoms in compounds.

The detection of the process of dialysis, by Graham, has thrown a much needed light upon a variety of phenomena both in nature and art. Another important step has been the liquefaction and solidification of those so-called permanent gases which had resisted the earlier attempts of Faraday. This discovery is of prime value, not only as upholding the law of continuity, but as elucidating the behaviour of gaseous bodies under pressure and revealing the interesting phenomena of the "critical points."

The study of the behaviour of bodies with reference to light has been rewarded by two discoveries, photography

and spectroscopy, which, if they have not had a great effect upon chemical theory, have supplied every department of science with precious aids in research.

Thermo-chemistry, the study of the heat evolved or absorbed during chemical changes, has been diligently and fruitfully studied, and has coordinated a number of chemical phenomena, which have hitherto seemed desultory and unconnected.

Undoubtedly one of the grandest steps taken in pure chemistry within our epoch has been the discovery of the periodic law. This generalisation, as a reference to our columns will show (Chemical News, vols. vii., x., xii., and xiii.), was in the first place due to our countryman Mr. J. A. R. Newlands. It was some time afterwards independently discovered by Prof. Mendeleeff, and has since been developed both by that eminent savant and by Professors Meyer and Carnelley.

What will be the next great step in scientific chemistry it would be rash to predict. May we venture to hope it will be at least some approach to a demonstration of the compound nature of our conventional "elements," in which direction both experiment and theory seem already pointing?

In our next issue we shall endeavour to summarise the leading features in the progress of analytical chemistry and of the chemical arts.

NOTE ON THE SOFTENING OF MAGNESIAN WATERS BY CLARK'S PROCESS.

By J. ALFRED WANKLYN.

Committee-Rooms in the Houses of Parliament are sometimes pervaded with an atmosphere which is unfavourable to sound chemistry. On a recent occasion Dr. Frankland, senior, and those who were associated with him in opposition to a Water Bill (which was defeated), pledged themselves to the maintenance of the following assertions:—That it (the Clark process) is not applicable to waters containing a large quantity of magnesia; and that in the particular case of the Sudbrook water—a highly magnesian water—the Clark process would not remove more than one-quarter of the magnesia.

I will place on record direct experiments which I have made, and which negative that which Dr. Frankland laid before the Committee. Sudbrook water contains—

	Grains per gallon.
Carbonate of lime	13·6
Carbonate of magnesia	5·4
Sulphate of magnesia	3·2
Nitrate of magnesia	0·6
Chloride of magnesium	0·8
Chloride of sodium	3·5
	27·1

It is highly charged with loosely combined carbonic acid. On submitting the water to the Clark softening process I found that the precipitation by the lime was most satisfactory, the precipitate being easy to remove either by filtration or subsidence.

In my first experiment the total solids in the softened water fell to 11 grains, and contained—

CaO	3·4	grains per gallon.
MgO	1·22	,, ,,

In the second experiment the total solids in the softened water fell to 9¼ grains per gallon:—

CaO	1·57	grains per gallon.
MgO	1·44	,, ,,

I have also consulted Mr. Porter, the eminent engineer, who is so successfully working the Clark process on the large scale. He has no difficulty with magnesian waters.

ON THE DESTRUCTION OF PARASITIC FUNGI BY USING IRON SULPHATE.

By Dr. A. B. GRIFFITHS, F.R.S. (Edin.), F.C.S. (Lond. & Paris Principal and Lecturer on Chemistry, School of Science, Lincoln.

Having been the exponent for the use of iron sulphate (in small quantities) as a manure (see *Journ. Chem. Soc. Trans.*, 1883, '84, '85, '86, '87), the author of this note wishes to allude to several scientific investigators who are using iron sulphate for destroying various micro-organisms which attack farm and other crops.

It will be remembered that the author has shown in several papers the power of iron sulphate as an antiseptic agent for the destruction of *Peronospora infestans* and the "wheat-mildew" (Chemical News, vol. xlix., p. 279); *Journ. Chem. Soc. Trans.*, 1886, p. 119; Chemical News, vol. liii., p. 255; *Chemiker Zeitung*, No. 47).

Several foreign scientific men have also proved the efficacy of ferrous sulphate for the destruction of the large number of fungoid growths which attack the vine. Amongst these are the following:—

1. Recently Dr. F. von Thümen* uses a 10 per cent solution of ferrous sulphate for the destruction of *Phoma vitis* and *Phoma Cookei*, two fungoid growths which attack the vines of Austria and Hungary.
2. M. Millardet employs 1 kilogrm. of iron sulphate in 2 litres of water, for washing the stocks of vines a fortnight before the shoots begin to start.
   Mme. Ponsort, in Bordelais, uses a mixture of 4 parts of iron sulphate and 20 parts of lime for the same purpose (see Trouessart's "Microbes, Ferments, and Moulds," *Intern. Scientif. Series*, vol. lvii., p. 38).
3. Dr. H. Müller and others (*Biedermann's Centralblatt fur Agricultur-chemie*, 1883, p. 630) have found a solution of 1 part of iron sulphate in 2 parts of water an excellent remedy for destroying *Peronospora viticola*, which attacks the Prussian vines.
4. M. A. Guillamont (*Biedermann's Centralblatt fur Agricultur-chemie*, 1883, p. 272) states that a mixture of 10 parts of iron sulphate, 10 parts of wood-ashes, and 2 parts of coal-tar is a good specific for destroying the Phylloxera.
5. The well-known botanist, Prof. J. von Sachs, of Würzburg University (*Biedermann's Centralblatt fur Agricultur-chemie*, 1886, p. 602), uses iron sulphate for trees and plants generally as a remedy for the disease known as "chlorosis in plants."

In the author's papers already referred to it has been shown that the iron sulphate acts upon the cellulose walls of these parasitic fungi.

These notes may prove useful, for it is not unlikely (owing to the present state of the weather in certain parts of the country) that our farm crops may be attacked by parasitic diseases.

THE CEMENT INDUSTRY IN ITALY.

By KONRAD WALTER, Chemical Engineer.

There is scarcely anywhere in Europe another country to be found which is, like Italy, by nature rich in building materials of all descriptions. All along the Apennines, especially in Tuscany, and in the Alps, near the Lombardian lakes, we find precious marble in all its varieties; in the Lombardian and Venetian plains there is, in large quantities, excellent clay for the manufacture of bricks and tiles; and in the pre-Alps and Apennines we have

* "Die Phoma-Krankheit der Weinreben verursacht durch die parasitischen Pibze *Phoma vitis* und *Phoma cookei*," von F. v Thümen reviewed in the Chemical News, vol. lv., p. 246).

almost everywhere not only the purest carbonate of lime, but also—and especially in the parts of Bergamo, Lecco, and Arona, and on the hills of Piedmont, in the districts of Casale Monferrato, Alessandria, Vercelli, &c.—an excellent raw material for the manufacture of natural and artificial Portland and Roman cement.

Although these natural treasures exist in almost immeasurable quantities, their industrial application—except the marble industry—is still in a state of infancy. The manufacture of bricks and tiles, with the exception of three or four large establishments, is carried on by hand; the burning of lime is effected almost everywhere in the most primitive kilns, and the manufacture of the valuable Portland and Roman cements is conducted without chemical knowledge in the matter itself, and without regard to economy in fuel and milling expenses.

No wonder, therefore, that Italy has a continual and yearly increasing importation of cements from foreign countries, especially from France, whereas its geographical position, and its almost inexhaustible deposits of the best natural raw material, could make it become an exporting country. In the statistics we find that the importation of cement has been—

In 1884	.. ..	32,543 tons
In 1885	.. ..	34,430 ,,
In 1886	.. ..	39,260 ,,

whereas in 1879 it was only about 17,000 tons. This is not only proof that the consumption of cements in Italy is increasing from year to year, but also that the home production does not keep up with the increasing demand.

To a certain extent this is due to the little enterprising spirit of the Italians and to the want of capital for industrial enterprises: by far the greatest part, however, is due to the old-fashioned and uneconomical way in which the cement manufacture in Italy is conducted, and the distrust and aversion met with when trying to introduce new inventions and economical processes. In England, Germany, and France, where coal can be had at the works at from 7 to 8 francs per ton, every manufacturer is only too glad to introduce at his works any new improvement by which the smallest saving in fuel can be effected. But if in Italy—where the average price of coal at the works is at present about 30 francs per ton—such improvements are proposed to the manufacturer, the almost general answer is that coal is at present so very cheap, and trade is so bad, that it is not the right time to make experiments and improvements which require an outlay of capital; thereby not considering that this comparatively small outlay of capital is just the thing to improve trade and effect great savings, and that the proposed improvements are not at all problematical experiments, but are introduced already largely and approved of in the most eminent industrial countries.

The Portland cement industry in Italy is even now a good business, but it could be made a first-class one if it were in the hands of intelligent capitalists who would be open to such improvements as could be introduced.

These improvements would be, first of all, the doing away with the old system of furnaces, which have a consumption of above 26 per cent of fuel, and introducing such new systems as, for instance, the furnace Dietzsch, now almost generally used in Europe, and by which scarcely 10 per cent of fuel is used. A further improvement and great saving would be a general re-organisation of the milling of the burnt cement, which up to now has been very costly, by introducing such new mills and crushing machinery as are now used in England,—for instance, the mills of Messrs Morris Brothers, of Doncaster, which effect a saving of more than 50 per cent on the milling cost.

With similar improvements the Portland cement industry in Italy could not only be brought to such a point as to supply all the wants of the country itself, but it could even be extended to exportation, considering the excellent quality and cheapness of the natural raw cement material, which, in spite of the high price of fuel in Italy, would be able to compete with almost any country in Europe as regards quality and cost of production. But even leaving aside the idea of exportation, there ought to be a great future for the Portland cement industry in Italy. All the large projects of river regulation, seaport and harbour, buildings of the Government (which are only in part commenced, and partly to be commenced soon), as well as the really great building projects of Milan, Rome, and Naples, require for the next twenty-five to thirty years such quantities of cement that, even by limiting the production only to the home consumption, enormous profit could be made.

In order to show still more clearly what an excellent business the Portland cement industry in Italy could be, we will only give a few notes regarding the cost of production and actual selling prices.

At Casale Monferrato, where the best Italian Portland cement is made, there are now in use the intermittent kilns and circular furnaces (Hofmann's system), and only one furnace on Dietzch's system is now at work. The consumption of fuel in these three different systems of furnaces is at present per ton of 1000 kilos. of burnt cement:—

In kilns = 279 kilos. of English coke.
In circular furnaces = 237 kilos. of Newcastle coal.
In Dietzsch's furnace = 100 kilos. of small coal.

English coke costs, at the works at Casale, 42 frs. per ton; Newcastle coal, 27 frs.; and small coal, 26 frs.

The expenses of fuel are therefore at Casale Monferrato, per ton of 1000 kilos. of burnt cement,—

In the kilns	11·52 frs.
In the circular furnaces ..	6·40 ,,
In the Dietzsch furnace ..	2·60 ,,

We have therefore in this special case a saving in fuel, in favour of the new system of Dietzsch, of 8·92 frs. against the kilns, and of 3·80 frs. against the circular furnace per ton; and as a double Dietzsch furnace gives an annual production of about 6000 tons of burnt cement, the total saving in fuel alone by the above-named production, and by the use of this system, is 53,520 frs. against kilns, and 22,800 frs. against circular furnaces.

The working cost (expenses for labour) per ton of burnt cement is about the same by all three systems.

Accurately made trials have shown that the Portland cement obtained in the furnaces system of Dietzsch is, as regards quality and mercantile value, not only equal to, but even better than by the other systems.

The saving in milling expenses which can be made by introducing the new mills of Messrs. Morris Brothers, of Doncaster, is also very considerable.

The milling is at present made in stone-mills, and to reduce 20 tons of burnt cement to the fine powder wanted in commerce requires an 80 H.P. steam-engine and a large number of workmen, besides many different auxiliary machines. The expense of reducing a ton of cement to powder is therefore here about 10 frs.

A Morris mill reduces, per working hour, about 1000 kilos. of cement to the finest powder, and requires, together with a Marsden stone-breaker, which breaks up the big pieces to a suitable size for the mill, from 12 to 14 H.P. and very few men. We have therefore more than 50 per cent saving in milling expenses by using this mill.

Milan, May 21, 1887.

Reproduction of Alabandine.—H. Baubigny.—A solution of manganese acetate, even if slightly acidified with acetic acid, gives an abundant precipitate if treated in the cold with sulphuretted hydrogen. There is formed the well-known rose-coloured sulphide, which, if heated to 100° in a closed vessel, is transformed into the compact green variety. On prolonged standing, crystals are produced, even at common temperatures, and prove to be alabandine.—*Comptes Rendus*, Vol. civ., No. 20.

ON RED AND PURPLE CHLORIDE, BROMIDE AND IODIDE OF SILVER: ON HELIOCHROMY AND ON THE LATENT PHOTOGRAPHIC IMAGE.*

By M. CAREY LEA, Philadelphia.

(Concluded from p. 267.)

Action of Various Metallic Oxides on Silver Oxide.

If we precipitate ferrous oxide with potash and add to this silver oxide, or what amounts to the same thing, if we add to ferrous sulphate potash in excess and pour over this silver nitrate solution, the silver oxide separated by the potash is partly reduced by the ferrous oxide, and when treated with HCl forms red chloride, the intensity of the colour of which depends within certain limits on the amount of reduction of the silver oxide.

Similarly if we treat solution of manganous sulphate with excess of potash and then add silver solution, we get an analogous reaction, except that it is much weaker and heat is necessary.

With chromous oxide the action is still weaker, but evident. With cobaltous oxide it is scarcely perceptible heat and long continued action.

Action of Ferric Chloride on Metallic Silver.

It has been long known that silver was blackened by ferric chloride, and this action has been proposed in the text-books as a means of obtaining subchloride, for which it is quite unsuited.

Ferric chloride acts on silver much as sodium hypochlorite does, but less rapidly. With hypochlorite the action is complete in a few hours or often in an hour or less; with ferric chloride one or two days are required before the product ceases to yield silver to hot dilute nitric acid. In both cases the action appears to be alike in this: that no sub-chloride is finally left uncombined with normal chloride.

The product is an intensely dark purple-black, when the action takes place in the cold. With heat continued for many hours, ferric chloride can be made to attack the purple salt and gradually convert it into AgCl. With a strong solution in large excess kept at or near 212° F. for sixty hours the colour was gradually reduced to pink and finally to a dingy pinkish grey. Pure white cannot be obtained, as it can by aqua regia.

In order to observe more exactly the course of the action, a strong solution of ferric chloride was allowed to act on reduced silver in fine powder for four minutes, and then a fresh portion (always in large excess) for the same time. Analysis showed that at this stage of the action the material contained—

Ag (determined)	76·07
Cl (by difference)	23·93
	100·00

If we suppose that all the silver was combined with chloride, the constitution of the substance would be—

AgCl	92·49
Ag_2Cl	7·51
	100·00

but this was probably not the case; there was almost certainly free silver present, and consequently a less proportion of sub-chloride. Another specimen, treated repeatedly with hot acid until every trace of free silver was removed, was found to contain 1·52 per cent of sub-chloride, colour purple. Another similarly treated contained 7·3 per cent sub-chloride.

Action of Nitric Acid on Silver Sub-chloride.

When freshly precipitated and still moist sub-chloride of silver is treated with nitric acid, a sharp effervescence, accompanied with a disengagement of red fumes, sets in; presently the strong red colouration of the photo-chloride appears and the action ceases. This production of the red and not the white chloride in the decomposition of Ag_2Cl is precisely what might have been expected, for when AgCl is formed in the presence of Ag_2Cl more or less combination always takes place.

The action is interesting in this respect: the AgCl first formed is at the moment of formation in presence of all the yet undecomposed portion of Ag_2Cl, and whatever part it combines with is removed from the action of the acid. It would therefore seem probable that this method would be one of those that yielded a product having the largest proportion of Ag_2Cl, but analysis showed that different specimens were extremely variable—of those analysed, one contained 8·62 per cent of Ag_2Cl, another 6·56, and a third 1·96. All that analysis can do with such substances is to fix the limits within which they vary. The quantity of sub-chloride left after treatment with nitric acid depends partly on the strength of the acid and the time for which it is allowed to act, but also to come extent on variations in the resistance of the substance itself. These specimens were of shades between rose and purple.

The colour of any particular specimen is always lightened in shade by abstracting Ag_2Cl from it by continued boiling with nitric acid. But as between different specimens, especially when formed by different reactions, it by no means follows that the darkest in colour contains the most sub-chloride.

Argentous chloride when treated with sodium hypochlorite yields a purple form of photo-chloride. A specimen so treated contained 2·57 per cent of Ag_2Cl.

Action of Cupric Chloride on Silver.

When metallic silver is submitted to the action of either cupric chloride, or what gives the same result, a mixture of copper sulphate and ammonium chloride, an action takes place very similar to that of ferric chloride, but more energetic, and the resulting red chloride is apt to be lighter in shade, though in this respect it varies very much. As in the case of ferric chloride this action of cupric chloride on silver is given in some text-books as a means of obtaining argentous chloride, for which purpose it is as little suited as the iron salt.

As a mode of obtaining red chloride it is not to be recommended. It is troublesome to get the copper completely removed.

A specimen analysed was found to consist of white chloride with 6·28 per cent of sub-chloride.

Action of Proto-chlorides on Silver Solutions.

Cuprous Chloride.—When very dilute solution of silver nitrate is poured over cuprous chloride, a bulky black powder results, which by boiling with dilute nitric acid turns red, the acid extracting little or no silver.

Ferrous Chloride.—When silver nitrate is dissolved in a slight excess of ammonia, and this solution is poured into a strong one of ferrous chloride there results a precipitate which is sometimes greyish, sometimes olive-black. By washing with dilute sulphuric acid, this product becomes brownish purple, and brightens by boiling with dilute nitric acid. It was found to contain 4·26 per cent of sub-chloride.

Photo-chloride by Action of Hydrogen.

When hydrogen is passed over argentic citrate at 212° F., as in Wöhler's process, there results a black or dark brown powder consisting of argentous citrate, metallic silver, and perhaps other substances. When this is treated with hydrochloric acid and subsequently with nitric, the resulting product is photo-chloride, the characteristic colour of which sometimes appears as soon as the HCl is added. But more frequently the material after the action of HCl has precisely the appearance of silver reduced in the wet way, and the red colour appears only after treatment with nitric acid. Even cold dilute acid (by some hours' contact) will isolate the red chloride; boiling acid does so at once.

* *Amer. Journ. of Science*, 3rd Series, vol. xxxiii., p. 349.

Colour, beautiful purple. A specimen analysed was found to consist of normal chloride combined with 3·11 per cent of sub-chloride.

Photo-chloride by Action of Potash with Oxidisable Organic Substances.

There is no better method of obtaining photo-chloride than by acting on a salt of silver with potash and certain organic substances. Milk sugar, dextrine, and aldehyd, give particularly good results. Milk sugar acts rapidly, dextrine slowly. Other substances with which, combined with potash, I have obtained chloride, are: gum, tannin, gallotannic acid, manna, glycerin, alcohol, carbolic acid, &c. The number might doubtless be indefinitely multiplied. After the action has reached a proper stage, which with milk sugar is apt to be in less than a minute and with dextrine may take half an hour, HCl is added, whereupon the precipitate changes in appearance but does not exhibit its characteristic colour until after boiling with nitric acid; the best result is obtained when the precipitate, after addition of HCl, has a rich chestnut-brown shade,* which by nitric acid changes to shades of purple and burnt carmine, when milk sugar, dextrine, or aldehyd has been the reducing agent. When the salt of silver employed has been the chloride, of course treatment with HCl is superfluous.

A specimen obtained by acting on silver nitrate with potash and dextrine was found to contain 2·26 per cent of sub-chloride. Another obtained with silver nitrate, potash, and milk sugar contained only 0·34 per cent. As in former instances these determinations are useful only in indicating the extreme variability of these substances and their approximate limits of composition.

Other Reactions leading to the Formation of Photo-chloride.

A few more instances are here added, indicating the variety of ways in which this product may be obtained.

The following is an interesting reaction. If a solution of ferrous sulphate is made strongly acid with HCl and solution of silver nitrate added, the silver is thrown down as white chloride. But if to the silver solution is first added a little ammonia, enough to re-dissolve the oxide, but much less than enough to neutralise the acid added to the iron solution, then, on pouring the silver solution into the iron, the silver falls as red chloride. So obtained it has at first a dull purple or shade, but by purification, as before described, a good product is obtained. This method, however, scarcely tends to the production of the splendid copper red shades of colour that are got by acting on silver chloride dissolved in ammonia with ferrous sulphate and then adding dilute sulphuric acid. The shade of colour shown by any particular specimen is always of interest, because, as before mentioned, it modifies the effect exerted upon it by the spectrum.

Potassio-ferrous Oxalate.—The now well-known "oxalate developer" which I described in the *American Journal of Science* some years ago, throws down from silver nitrate a black powder; this precipitate treated with HCl scarcely alters in appearance, but washed and boiled with dilute nitric acid changes to a deep purple.

Pyrogallol is capable of leading to the formation of photo-chloride. When ammoniacal solution of silver nitrate is poured into solution of pyrogallol in water made strongly acid with HCl, in such proportion that the mixed solutions remain strongly acid, there falls a greyish product which by washing and treatment with hot dilute nitric acid becomes bright pink.

Ferrous oxide differs essentially in its action on silver solutions from ferrous sulphate. A silver nitrate solution added to one of ferrous sulphate precipitates grey metallic silver. But if potash or soda is first added to the ferrous solution and then silver nitrate followed by HCl, the red chloride is formed abundantly. This reaction is similar to that already described in which an ammoniacal solution of a silver is added to one of ferrous sulphate.

To the same class of reactions belongs the following:—Silver carbonate with excess of sodium carbonate is thrown into solution of ferric sulphate, and after standing a few minutes HCl in excess is added. The silver is converted into red chloride.

It seemed possible that silver itself might be made the means of reducing its chloride. The experiment was made in this way:—Freshly precipitated and still moist chloride was intimately mixed with metallic silver in fine powder and a little water. This was heated till the water boiled and nitric acid was added. After the action was over the chloride had assumed a deep pink colour. A similar result is obtained without the aid of heat, but the resulting colour is much paler.

Analogous to this is the following:—When a cake of fused silver chloride in a crucible is reduced with dilute sulphuric acid and zinc, if the reduction is interrupted when not quite finished, and the metallic silver is dissolved out with hot nitric acid, the residue of silver chloride will be found to be pink.

When HCl is brought into contact with Ag together with an oxidising agent such as a bichromate or permanganate, it gives rise to formation of coloured chloride. These I have not specially examined, but there can be little doubt that they are identical in nature with the foregoing. So too when silver in contact with mixed potassium chloride and chlorate is cautiously treated with dilute sulphuric acid.

The reactions above described will serve to show under what a vast variety of conditions the photo-salts are formed. Most of the methods here described represent each a whole class of reactions, all resulting in the same general way, and these classes might doubtless be largely added to. Almost any silver solution brought into contact with almost any reducing agent and then treated with HCl, gives rise to the formation of photo-chloride. Almost any chlorising influence brought to bear on metallic silver has the same result. Or when silver is brought into contact with almost any oxidising agent and HCl, it may be said without exaggeration that the number of reactions that lead to the formation of photo-chloride is much larger than that of those leading to production of normal chloride.

Reactions of Photo-chloride.

Exposed to ordinary diffuse light all the bright shades of silver photo-chloride quickly change to purple and purple-black. The darker shades are more slowly influenced.

Mercuric chloride gradually changes it to a dirty white.

Mercuric nitrate dissolves it easily and completely, but apparently with decomposition, as it can only be recovered as white chloride.

Potassic chloride seems to be without effect.

Potassic bromide soon converts it to a dull lilac, which at the end of twelve hours showed no further change.

In contact with potassic iodide the colour instantly changes to blue-grey; this change is produced by a quantity of iodide too small to dissolve even a trace of silver; the filtrate is not darkened by ammonium sulphide. With a larger quantity silver is dissolved abundantly. By acting with renewed iodide solution, the substance continually darkens and diminishes until only a few black points, barely visible, are left.

Treated with dilute solution of potassium chlorate and HCl, the red substance gradually passes to pink, to flesh-colour, and finally to pure white.

The action of heat on the photo-chloride is very curious; its tendency is generally toward redness. Specimens appearing quite black are rendered distinctly purple or chocolate by heating to 212° F. in a drying oven. Often when the substance first separates by addition of HCl, it is pure grey; this grey will often be changed to pink by simply heating to 212°. (This happens when a grey form

* A specimen in this stage and before treatment with nitric acid was found to contain 92·63 per cent of silver, showing it to be a mixture of metallic silver with chloride and sub-chloride.

is produced; if the greyness is due to admixed metallic silver, it is only removed by boiling with nitric acid.)

The somewhat surprising change of colour which is often seen when the crude substance is boiled with nitric acid (sometimes from dull dark grey to crimson) is due to three concurrent actions: that of the mere heat, the removal of the silver, and the breaking up of uncombined subchloride.

It is not possible to dissolve out the normal chloride by a solvent like ammonium chloride from the photochlorides, leaving the subchloride behind. When red chloride is boiled with successive portions of strong solution of ammonium chloride in large excess, the material gradually diminishes until, if the operation is continued long enough, there remains a small residue of a warm grey colour, which consists of metallic silver and dissolves without residue in nitric acid.

If sodic chloride is substituted for ammonium chloride, the same result follows, except that the operation is greatly more tedious. If persevered in until the hot solution no longer removes traces of silver chloride, the residue consists of nothing but metallic silver.

Action of Light on Normal Silver Chloride.

When silver chloride precipitated with excess of HCl is exposed to light, it becomes with time very dark. Cold, strong, nitric acid, 1·36 sp. gr., extracts a trace only of silver.

The principal action of light on AgCl (precipitated in presence of excess HCl) consists in the formation of a small quantity of subchloride which enters into combination with the white chloride not acted upon, forming the photochloride, and thus is able to withstand the action of strong nitric acid. At the same time a trace is formed, either of metallic silver or of uncombined subchloride, it is impossible to say which. After a certain very moderate quantity of photochloride is formed, the action of light seems to cease. This cessation has been noted by many observers, perhaps most exactly by Dr. Spencer Newbury.

The nature of the product formed by the continued action of light on silver chloride seems to support the conclusion that the subchloride is combined with the whole of the normal chloride after the manner of lakes rather than in equivalent proportions. If the latter were the case it seems probable that the continued action of light would extend to much greater decomposition than it is found to do.

The action of light in the formation of the so-called latent image will be examined in the second part of this paper.

PHOTOBROMIDE AND PHOTOIODIDE.

It has been already mentioned that bromine and iodine form with silver combinations in all respects analogous to those of chlorine. A more particular account of the bromine and iodine compounds must wait for a succeeding number of the *American Journal of Science*; here it can only be mentioned that these substances are formed much it the same way as the chlorine compound. They are less stable than it, and consequently the number of reactions that lead to their production is somewhat more limited. Each, however, is formed in a great variety of ways, and with the same ease as the chloride. In colour they are for the most part indistinguishable from it, but exhibit different reactions.

RELATIONS OF PHOTOCHLORIDE TO HELIOCHROMY.

The photochloride was examined both with the spectrum and under coloured glass.

The rose-coloured form of photochloride was that which gave the best effect. In the violet of the spectrum it assumed a pure violet colour, in the blue it acquired a slate blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged. The maximum effect was about the line F, with another maximum at the end of the visible violet, less marked than the one at F.

Under coloured glass the colours obtained were brighter; under two thicknesses of dark ruby glass the red became brighter and richer. Under blue glass some specimens gave a fair blue, others merely grey. Under cobalt a deep blue was easily obtained, and under manganese violet a fine violet, very distinct in shade from the cobalt. Green produced but little effect—yellow was sometimes faintly reproduced, but rarely. But the yellow glass of commerce, even the dark yellow, lets through portions of nearly the whole spectrum, as can readily be seen by testing it with the spectroscope.

The dark purple forms of chloride do not give as good results as the rose and coppery shades. These last have many points of resemblance with the material of Becquerel's films, resemblance of colour, probably of composition, as far as we can judge of the constitution of those films from their origin; they were far too attenuated to admit of analysis; and resemblance in the curious way in which their colour is affected by heat, so that the conclusion seems inevitable that they are at least closely related.

There is certainly here a great and most interesting field for experiment; hardly any two specimens of photochloride give exactly the same results with coloured light, and this suggests great possibilities. There is the very great advantage in this method over any previous, that the material is easily obtained in any desired quantity and in a condition most favourable for experiment.

The action of light on photochloride can be a good deal affected by placing other substances in contact with it. Any substance capable of giving up chlorine seems to influence the action somewhat; ferric chloride often acts favourably, also stannic and cupric chlorides.

Evidently an important point in all heliochromic processes is that as white light must be represented by white in the image, it is an essential condition that white light must exert a bleaching action on the sensitive substance employed. Red chloride does not bleach but darkens in white light, but the property of bleaching, to a very considerable extent, may be conferred on it by certain other chlorides, and particularly by lead chloride and zinc chloride.

This I look upon as very important.

Another matter of interest is exaltation of sensitiveness, and this I find is accomplished in quite a remarkable way by sodium salicylate, the presence of which at least trebles the action of light on these substances. And probably on others.

I am persuaded that in the reactions which have been here described lies the future of heliochromy, and that in some form or other this beautiful red chloride is destined to lead eventually to the reproduction of natural colours.

METHODS FOR DETERMINING THE RELATIVE STABILITY OF THE ALKYL BROMIDES.*

By IRA REMSEN and H. W. HILLYER.

A CAREFUL study of the relative ease with which bromine can be extracted from the alkyl bromides by different reagents would undoubtedly reveal many facts of interest and importance. Unfortunately such a study is extremely difficult, owing to a variety of circumstances. In the first place, the bromides of the lower members of the series are quite volatile, and, if allowed to stand at the ordinary temperature, the quantity of substance under experiment constantly decreases. In the second place, the bromides are not soluble in water, a fact which makes it difficult to apply reagents which are insoluble in alcohol. Again, the method which first suggests itself—viz., reduction by means of nascent hydrogen—is one which it is extremely difficult to apply quantitatively. Notwithstanding these and other obstacles, it was thought desirable to make a preliminary study of the different methods which suggested themselves, with the view of determining which of the

* *American Chemical Journal*, vol. viii., p. 251.

methods are most promising, and what the general character of the results obtained is. These results cannot lay claim to great accuracy, but, as will be seen, they are interesting as showing the relative stability of the bromides which were investigated. The bromides experimented upon were those at hand,—ethyl bromide, normal and isopropyl bromides, butyl bromide, and amyl bromide (boiling-point 119°).

Action of Zinc and Sulphuric Acid.

The first experiments which yielded results of interest were those in which the reducing agent was hydrogen from zinc and sulphuric acid. A solution containing 75 c.c. of equal parts of alcohol of about 94 per cent and of sulphuric acid of about 10 per cent, and a quantity of bromide, such that it contained 200 m.grms. of bromine, was placed in an Erlenmeyer flask of 125 c.c. capacity. The zinc used was the common sheet zinc, cut in pieces of one inch by one-half inch. These were bent in the middle at a right angle, so that, when resting upon the two ends, they would expose as uniform an extent of surface as possible. They were cleaned and slightly etched with dilute sulphuric acid, then washed and placed in the flasks, four in each flask, by means of a platinum wire hook, or, better, a small tapering glass rod, bent at a right angle near the end.

The extent of the reduction was determined by estimating by Volhard's method the quantity of bromine abstracted. It was soon discovered that the nitrate of silver decomposed the bromides to a considerable extent, so that in the later experiments the method used consisted in adding ferric sulphate and a small quantity of sulphocyanate solution, and then titrating to disappearance of colour, thus leaving the nitrate as short a time as possible in contact with the bromide. The titrating solutions were so made that each cubic centimetre was equivalent to 1 m.grm. of bromine.

In this way ethyl, isopropyl, and butyl bromides were first examined. It was found that a larger percentage of alcohol was necessary for the solution of the amyl bromide, so that in a second series, in which isopropyl, amyl, and normal propyl bromides were examined, the solvent was 50 c.c. alcohol and 40 c.c. acid. The figures indicate the total number of milligrammes of bromine abstracted from the bromides. This is true also of all subsequent tables given in this paper. All of the experiments of shorter duration described in this paper were carried on in flasks surrounded by flowing water of 9° or 10° temperature. The flasks in the other experiments were also put in water, but the flow of water was not kept up, so that the temperature varied slightly with the temperature of the laboratory. In the first series of experiments, the results of which are recorded below, the time of action was two and a half hours.

Series I.

Experiment 1.	Butyl, 3·9	Ethyl not measurable.	
,, 2.	,, 3·9	,, 0·7 (?).	
,, 3.	,, 3·9	,, 6 and 1·2.	
,, 4.	,, 3·3	Isopropyl, 10·6 and 8·4.	
,, 5.	,, 3·3	,, 9·6 and 7·8.	

It will be seen that the five experiments with butyl bromide gave results which agreed fairly well with one another, a fact which shows that the method is worthy of consideration. In the four experiments with ethyl bromide the results varied from a quantity of bromine which was too small to be determined to 1·2 m.grms. Finally, in the case of isopropyl bromide, the quantities of bromine extracted in the four cases varied from 7·8 to 10·6. While these results are not as satisfactory as could be desired, they clearly show the relative ease with which the three bromides experimented upon are decomposed by the reagent used. Leaving out the first experiment with ethyl bromide, it appears that, under the same conditions, hydrogen from zinc and sulphuric acid extracts from four to five times as much bromine from butyl bromide as it does from ethyl bromide, and about three times as much from isopropyl bromide as from butyl bromide.

Series II.

Experiment 1.	Isopropyl, 6·7	Amyl, 3·2 and 3·2.
,, 2.	,, 5·9	N. propyl, 0·7 and 0·7.

The time in these experiments was not as long as in the first series.

The results show that the amyl bromide used is somewhat more easily decomposed than normal butyl bromide, and that normal propyl bromide has approximately the same stability as ethyl bromide. The order of stability towards nascent hydrogen evolved from zinc and sulphuric acid is, beginning with the most stable, ethyl, normal propyl, normal butyl, amyl (from fermentation alcohol), and isopropyl bromide. The most important general statement to which the results lead is that *the bromides of primary alcohols decrease in stability towards zinc and sulphuric acid as we pass from the lower members of the series to the higher.*

The marked instability of isopropyl bromide, as compared with normal propyl bromide, indicates that the secondary bromides are much less stable than the corresponding normal bromides.

Another series of experiments confirmed the results already commented upon, as far as the order of stability is concerned.

Action of Nascent Hydrogen evolved from an Alkaline Solution.

Some time ago, at the suggestion of one of us (R.), Mr. E. H. Keiser tried some experiments on the action of sodium amalgam on alcoholic solution of alkyl bromides. The results were later found to be untrustworthy, because the alkali alone was found to decompose the bromides, and, as no allowance had been made for the double action, it was impossible to decide how much of the total action to attribute to the alkali and how much to the hydrogen. The fact that when sodium amalgam is used the quantity of alkali in solution is constantly increasing throughout the experiments, and at a comparatively rapid rate, complicates the conditions of the experiments. Accordingly another method for getting nascent hydrogen from an alkaline solution was desirable, and the following was devised :—

It had been observed that when zinc is put into an ammoniacal solution of cobalt sulphate it soon becomes coated with a firm, glossy coating of cobalt, and that in this condition it gives a fairly good evolution of hydrogen when placed in a solution of caustic soda. The zincs were prepared by placing them in a shallow dish resting on their ends, and covering them with a strongly ammoniacal solution of cobalt sulphate containing 1 or 2 grms. to the litre, and sufficient ammonium sulphate to keep the cobalt in solution as double sulphate. The zincs were allowed to remain in this for a short time, till there was quite a rapid evolution of hydrogen, when the solution was poured off and the zincs washed. They were rendered more active by treating them with very dilute sulphuric acid and washing them a second time with several changes of water.

In the first experiments a large number of zincs were treated at once with the cobalt solution, with the object of making them of equal reducing power. The caustic soda solution was made from sodium by dissolving about 65 grms. of metallic sodium in a litre of alcohol of about 75 per cent.

The solutions, when in action, contain 30 c.c. alcohol, 20 c.c. water, 10 c.c. caustic soda solution, and a quantity of bromide containing 200 m.grms. of bromine. The soda solution was added, by means of a pipette, as rapidly as possible to the different flasks making up a series for comparison. At the end of the action the zincs were removed in the order in which they had been introduced,

thus securing a very nearly equal time for the action of the zincs in each flask. An equal quantity of nitric acid was then added to each flask, sufficient to neutralise the alkali. In order to have a control of the rate of action in each series there was one flask with ethyl bromide and no zincs and one with ethyl bromide and four zincs. Parallel with these was run a series containing eight other flasks with some other bromide, four with four zincs each, and four without zincs, with the object of determining the action due to the hydrogen, by subtracting from the total amount of bromine extracted the quantity extracted by the alkali alone in the flasks without zincs. The action continued for about sixteen hours.

First Day's Experiments.

	With Zn.	Without Zn.	Difference.
Ethyl	46·2	28·7	17·5
Amyl	17·8	4·9	
,, ...	19·9	4·2	
,, ...	19·2	4·5	
,, ...	19·9	4·9	
Mean ..	19·2	4 6	14·6

Second Day's Experiments.

	With Zn.	Without Zn.	Difference.
Ethyl	44·1	26·6	17·5
Butyl	12·4	3·4	
,, ...	12·4	3·1	
,, ...	11·9	3·4	
,, ...	12·9	3·4	
Mean ..	12·4	3·3	9·1

Third Day's Experiments.

	With Zn.	Without Zn.	Difference.
Ethyl	42·0	26·4	15·6
Isopropyl ..	13·7	3·5	
,, ..	13·5	3·3	
,, ..	14·0		
,, ..	13·7		
Mean ..	13·7	3·4	10·3

As the quantity of bromine extracted from ethyl bromide in the third day's experiments is smaller than in the experiments of the first and second days, it is probable that the figure for isopropyl bromide does not truly represent its stability as compared with the bromides used in the experiments of the first and second days. The proportion 15·6 : 17·5 :: 10·3 : x ought to give a figure comparable with the 14·6 obtained for amyl bromide and 9·1 obtained for butyl bromide.

Two series of observations were now carried on, each series including ethyl, normal propyl, isopropyl, butyl, and amyl bromides. The results obtained in each series are comparable with one another, but the results obtained in Series I. are not comparable with those obtained in Series II., as the conditions were not exactly the same in the two.

	Series I.	Series II.	
Ethyl	40·9	54·2	with zincs.
,, ...	28·0	35·7	without zincs.
,, ...	12·9	18·5	difference.
N. propyl ..	24·5	32·2	with zincs.
,, ..	9·8	11·9	without zincs.
,, ..	14·7	20·3	difference.
Isopropyl ..	11·5	16·4	with zincs.
,, ..	5·6	4·9	without zincs.
,, ..	5 9	11·5	difference.
Butyl	11·2	12·6	with zincs.
,, ...	3·5	3·8	without zincs.
,, ...	7·7	8·8	difference.
Amyl	16·8	18·5	with zincs.
,, ...	4·5	5·6	without zincs.
,, ...	12·3	12·9	difference.

These results, as well as those on preceding column, show at least that, whether we consider the total action of the alkali and the hydrogen, the action of the hydrogen alone as shown by the differences, or the action of the alkali alone, the order of stability is entirely different in these experiments from that obtained in the experiments with zinc and sulphuric acid. *In acid solution ethyl and normal propyl bromides are most stable, and isopropyl bromide least so. In alkaline solutions, on the contrary, the reverse is true; that is to say, ethyl and normal propyl bromides are least stable, and isopropyl bromide is, of these three, the most stable.* The results are less striking as far as butyl and amyl bromides are concerned. These bromides appear to have about the same stability towards alkali alone as isopropyl bromide, very much greater than ethyl bromide. On the other hand, the presence of the zincs increases the decomposition to about the same extent in the case of amyl bromide as in that of ethyl bromide, while in the case of butyl bromide the increase is somewhat less.

(To be continued).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 11th, 1887.

Shelford Bidwell, F.R.S., Vice-President, in the Chair.

A number of Puluj and other vacuum tubes were exhibited by Dr. Warren de la Rue. The Puluj tubes consisted of a phosphorescent lamp, and radiometers with phosphorescent vanes, and mica discs painted with phosphorescent substances. The other tubes contained different phosphorescent minerals, such as magnesium carbonate, calcium silicate, and Iceland spar. When illumined by a large induction-coil beautiful colour effects were produced.

The following papers were then read:—

"*Note on Beams Fixed at the Ends.*" By Profs. Ayrton and Perry.

This paper contains a simple method of solving problems relating to horizontal beams with vertical loads, and fixed at both ends. The curve of bending moment for the given distribution of load is first plotted supposing the beam "*supported*" at the ends; and the constant c, by which the ordinates of this curve exceed those of the true curve, is determined from the condition that the angle between the end sections must be nought. If M is the bending moment at a section, I the moment of inertia of the section about its neutral line, and E Young's modulus of elasticity for the material, then—

$$\frac{M}{E\,I}$$

is the curvature of the beam at that section. If o o' is a short length of the beam, the angle between the originally parallel sections at o and o' is—

$$\frac{M}{E\,I}.\,o\,o'.$$

Hence if the beam be divided into a great number of parts, and the values of M and I determined at the middle of each, then—

$$\Sigma \frac{M}{I} . oo' = o \quad . \quad . \quad . \quad (1)$$

since E is supposed constant. But $M = m - c$, where m is the bending moment at the same section, supposing the ends "supported."

$$\therefore \Sigma \frac{m-c}{I} = o; \qquad \text{or } \Sigma \frac{m}{I} = \Sigma \frac{c}{I} .$$

$$\therefore c = \frac{\Sigma \frac{m}{I}}{\Sigma \frac{1}{I}} \quad . \quad . \quad . \quad . \quad (2)$$

The following rule results:—Knowing m and I at every point, divide the beam into any number n of equal parts, find $\frac{m}{I}$ at the middle of each part, and take their sum; this gives the numerator of (2). Find $\frac{1}{I}$ at the middle of each part; their sum gives the denominator of (2). From this c is determined. Diminish all the ordinates of the m diagram by c, and we have the diagram of bending moment for a beam fixed at both ends, with any assumed distribution of load and variation of cross section. Particular cases are worked out in full. Numerous drawings made by students of Finsbury Technical College were exhibited, showing applications of the method to different distributions of loading.

"*Note on Messrs. Vaschy and Touanne's Method of Comparing Mutual Induction with Capacity.* By Prof. G. C. FOSTER.

In November last the author described a method of comparing the mutual induction of two coils with the capacity of a condenser. Since then he has found that a very similar method was used by Messrs. Vaschy and Touanne, in July, 1886, and published in the *Electrician* the following month. The formulæ are identical, and the difference consists in interchanging the galvanometer and the variable resistance p. Messrs. Vaschy and Touanne's arrangement has the advantage that the resistance of the secondary coil need not be known. Prof. Foster's method had been used by one of his students (Mr. Draper) about two years ago, but priority in publication belongs to Messrs. Vaschy and Touanne.

Prof. PERRY asked the meeting for suggestions to explain why a strip of steel twisted about its longitudinal axis at a red heat, and allowed to cool, tends to untwist when under tension; and for a formula to calculate the amount.

"A Note on Magnetic Resistance," by Profs. Ayrton and Perry, was postponed.

NOTICES OF BOOKS.

Report on the Purity of Ice from Onondaga Lake, the Erie Canal, and Cazenovia Lake. By J. T. GARDINER.

IT is a matter of common belief that water, while freezing, purifies itself. This is true to a certain extent, but how the idea should have become so general is difficult to say; possibly it has been deduced from the statements made by Arctic travellers, of melting the sea ice and being able to drink the water. This is accounted for in the following manner:—Salt water freezes at a lower temperature than fresh water, and at the same time loses some of its salt; after passing through the winter, the first warm rays of the sun raise the temperature very gradually, but sufficient for some of the brine to run off, leaving purer ice behind. Thus, after several successive summers and winters, the ice becomes sufficiently free from salt as to be drinkable when thawed; this explanation is borne out by the fact that it is always *old* ice which is used for procuring potable water.

Mr. Gardiner's examination of the ice from the districts herein mentioned was made for the purpose of proving whether or not organic impurities existing in the water were contained in the ice procured from that water, and it was found that, though it might free itself from some, yet it cannot get rid of all, and it is proved that ice always contains at least 10 per cent of the organic impurities in solution.

Besides retaining dissolved organic matter, ice also harbours bacteria, and Prof. Kendrick has found that −120° F. is not sufficient to destroy the germs of disease, and living organisms. The condition of Onandaga creek is such, that it is surprising that severe epidemics of disease are not of constant occurrence. The flow of the stream in summer falls as low as 10,000,000 gals. per diem, and yet some 5,000,000 gals. of sewage are daily poured into it; this stream of filth is one of the principal sources from which the lake is supplied, so the ice thence obtained has been very properly condemned.

The other places whence ice was obtained were examined, and though neither were so bad as that from Onandaga lake, still that from the Erie canal was condemned, as it appeared that better ice could easily be obtained from other places.

Easy Methods for the Examination of Milk. By Dr. PAUL VIETH. The Aylesbury Dairy Co. 1887.

THE writer of this pamphlet states that his intention here is only to put before the public in an easy manner methods of testing milk which are at the same time useful and reliable, and that this must not be considered as a treatise on the subject. On looking through the pages it is evident that he has succeeded in his object. He first describes the use and method of using lactometers, and the combined lactothermometer by which the specific gravity and the temperature of milk can be taken simultaneously by the same instrument. The unsatisfactory and often tedious method of estimating the quantity of cream in milk by "setting" is being gradually replaced by the ingenious machine known as the control centrifugal apparatus, in which 54 samples can be tested in fifty minutes; a similar machine used for separating the cream, called a lactocrit, is also used in some dairies. Both of these instruments are fully described and illustrated. Very extensive series of experiments have proved that the results obtained are in perfect agreement with those of the best gravimetric methods, while the saving of time is very considerable.

It was for a long time thought that the opacity of milk might be taken as a measure of the fat globules contained in it, and lactoscopes have been constructed for this purpose; but as the serum in which the fat floats is itself opaque, and likewise varies in opacity in different samples, it is not surprising that these instruments have, owing to being based on a wrong principle, failed to give satisfaction. The method of using Soxhlet's areometric process is fully gone into; much more correct determinations can be obtained by its means than by the lactobutyrometer.

At the end we find a table of corrections for temperature in taking the specific gravity, one for estimating the results obtained by the use of the areometer, the same for the butyrometer, and others.

Dangers of the Use of Whey and Cheese from the Milk of Tuberculous Cows.—V. Galtier.—The author has demonstrated by numerous and varied experiments the dangerous character of such products. Poultry and swine may also contract phthisis if fed upon dairy produce of this character, and their flesh may then, in turn, impart the disease to man.—*Comptes Rendus*, Vol. civ., No. 19.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—I have been unable till now to reply to Mr. H. M. Carrington's note in the CHEMICAL NEWS (vol. lv., p. 212), relative to the questions which were under discussion in your Journal some time ago. I may say that these questions are now receiving the serious consideration of the Council.—I am, &c.,

WILLIAM THOMSON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 19, May 9, 1887.

Fluctuations of Phosphoric Acid in Cow's Milk.—A. Andouard.—Phosphoric acid diminishes in milk from the beginning to the end of lactation. The butter, and especially the sugar, diminish likewise in quantity during the same interval. Of four cows, two gave an increasing and two a decreasing proportion of caseine. The increase of the solids of milk in the course of lactation is therefore not an invariable fact. The age of the cows under observation has only seemed to affect the quantity of the milk, the youngest having produced the least. The nutritive value of the food has evidently improved both the quantity and the quality of the milk. Contrary to the assertion of Kræmer, green forage is preferable to dry forage for milch-cows. The best green forages in Western France are by far cabbages and leguminous plants. Then follow in the order of merit potatoes, beet-root, and maize. Individuality appears to be the most important factor among those which modify the quantity and the composition of milk.

Influence of Materials Employed in the Construction of a Well on the Composition of the Mineral Water of Montrond.—M. Terreil.—In January, 1886, the author received for analysis a sample of mineral water from a recent bore-well at Montrond. It was found alkaline from caustic soda and lime without a trace of carbonic acid. After the lapse of twelve months the water was found to contain only one-fourth of its soda in the caustic state, the rest being carbonated; it further contained not a trace of lime. The author insists on the necessity of great care in sampling newly discovered waters.

No. 20, May 16, 1887.

Contribution to the Study of the Alkaloids.—Oechsner de Coninck.—The author examines the action of methyl iodide upon nicotine. On adding hydrochloric acid in excess to the alcoholic solution obtained, and pouring the whole into a large quantity of water, there appears a splendid green fluorescence, reminding the observer of fluoresceine. By transmitted light the liquid is orange, but by reflected light an intense green. The alcoholic solution, if acidified, colours silk and wool a yellow very similar to that of picric acid. But the fibre is not dyed, as the colour can be entirely removed by washing in water.

Action of Acetylene upon Benzene in Presence of Aluminium Chloride.—Raoul Varet and G. Vienne.—On causing acetylene to react upon benzene in presence of aluminium chloride, two successive reactions take place. The first yields cinnamene and the second diphenylethane and dibenzyle, which are isomers. Neither naphthalene hydride nor carbide are produced.

Justus Liebig's Annalen der Chemie, Vol. ccxxxviii., Parts 1 and 2.

Condensation-Products of Acetone and Acetophenone with Aniline and Ammonia.—P. Riehm.—The following are the principal results laid down in this memoir. Between ketones which contain a methyl attached to the CO and the aldehyds, there has been shown a further analogy in behaviour. That is, it has been shown that one CH_3 of the ketones can be split off just as the H-atom of the aldehyds. On the action of acetone upon aniline there is formed:—(1) An α-γ-dimethyl-chinoline with elimination of water and methane. (2) A tertiary base—

$$C_6H_5N = C\begin{matrix}CH_3\\CH_3\end{matrix}$$

with elimination of water. On the action of acetophenone upon aniline there is formed a crystalline base, boiling about 340°. It yields crystalline salts, which have not yet been closely examined. On the action of acetone upon ammonium chloride there is formed, at very high temperatures, β-collidine, with abscission of water and methane. On the action of acetone upon urea there are formed, at temperatures between 110° and 140°, β-collidine and a characteristic base, probably $C_{16}H_{19}N$. The substance formed on the action of acetophenone upon ammonia, *i.e.*, acetophenonine, has the empirical formula $C_{23}H_{17}N$, and must be regarded as triphenylpyridin.

Communications from the Chemical Institute of the University of Bonn.—These consist of a memoir by O. Wallach on the terpenes and ethereal oils, and one by E. Weber on the ethereal oils.

Researches on Gold.—Gerhard Krüss.—In this second paper the author submits previous determinations of the atomic weight of gold to an experimental criticism, especially as the results obtained vary considerably for each other. As a preparatory step to the re-determination of the atomic weight, he discusses the preparation of absolutely pure gold, for which he proposes three methods. He then examines the spark spectrum of gold and the influence of temperature upon spectral-analytical methods and determinations. This section will be reproduced at some length at the earliest possible opportunity. The last portion of this memoir, on the quantitative determination of gold, and its separation from the platinum metals, will also be given at length.

Synthetic Experiments with Acetacetic Ester.—L. Knorr.—A voluminous memoir, which does not admit of useful abstraction.

On Lactucerine.—Dr. G. Kassner.—The author obtains lactucerine from a residue of lactucarium, which is insoluble in benzine. This residue contains both caoutchouc and lactucerine.

The Alkaloids of Jaborandi Leaves.—Erich Harnach.—In addition to pilocarpine and jaborine, previously recognised, the author finds a well characterised base, pilocarpidine, which is capable of conversion into jaboridine.

MISCELLANEOUS.

Friedrich's New Mercury Pump.—There are at present two distinct systems of mercury pumps in use, viz., the Giessler and the Sprengel; the Sprengel is well known as giving a much higher vacuum than it is possible to obtain with any other pump, but its action is too slow when large receivers have to be exhausted. The Giessler pump and its various modifications are much quicker in their action, but they all have some drawbacks, such as a number of stopcocks, or long fragile tubes which are

liable to get broken. Friedrich's new pump is on the Geissler system, and though it does not claim to remove all the disadvantages possessed by the others, yet it succeeds, by means of a novel stopcock, in effecting several improvements and simplifying the manipulation. The stopcock referred to is a three-way one, but instead of the two borings going straight through the stopper, they lie oblique to its axis, and thus the gradual formation of the groove between collar and stopper is avoided, and a much more perfect joint secured, a very good vacuum can quickly be obtained, and, owing to its simplicity, the price of this pump is less than that of any similar one, which is another point in its favour.

MEETINGS FOR THE WEEK.

Wednesday, 22nd.—Geological, 8.
Thursday, 23rd.—Royal Society Club, 6.30. (Anniversary).
Friday, 24th.—Quekett Club, 8.
Saturday, 25th.—Physical, 3. "Note on Magnetic Resistance," by Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S. "On Sounding Coils," by W. Stroud, D.Sc., and J. Wertheimer, B.Sc. "On Comparing Capacities," by W. E. Rimington. "On the Effects of Change of Temperature in Twisting or Untwisting Wires which have Suffered Permanent Torsion," by Herbert Tomlinson. "On Permanent Magnet Ammeters and Voltmeters with Invariable Sensibility," by Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S.

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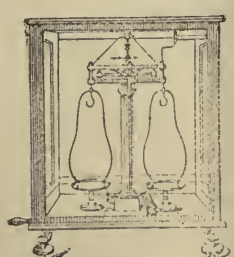

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THE CHEMICAL NEWS.

Vol. LV. No. 1439.

HER MAJESTY'S JUBILEE.—A SCIENTIFIC RETROSPECT.

II.

In no department has the progress effected during the last half century been more striking than in chemical analysis. In 1837 we were, practically speaking, confined to what is now known as the gravimetric method. This method has, in itself, been wonderfully developed; reagents are obtained of higher purity, balances and other instruments of a greater precision are now to be procured, and the results arrived at are more closely scrutinised and compared. Above all, possible sources of error have been jealously sought for, and have been found. Thus we now know that substances once deemed absolutely insoluble in water, in cold dilute acids, or in saline solutions, are liable to be appreciably attacked. We find that compounds once supposed to be thrown down from their solutions in a state of perfect purity, in reality entangle or occlude varying quantities of foreign matter, from which they are not always freed without much care and patience.

To take a very familiar instance: how simple seemed the determination of sulphuric acid in a complex saline solution, as described in manuals of the first third part of the century,—so simple that the veriest tyro of a laboratory boy could scarcely be supposed, except by malice aforethought, to come wide of the mark. But if we look over an analytical text-book, written in the light of the present day, we shall see laid down a number of precautions the neglect of which may involve errors in excess or in deficiency, as the case may be.

Along with the desire for increased accuracy there has sprung up a demand for dispatch—we might almost say for hurry—in the completion of an analysis. In pure science this demand is, of course, not felt. But where analyses are executed for technical and commercial purposes speedy execution is desired as much as, if not more than, thorough accuracy. In some technical and commercial establishments it is the rule that, however many samples are sent into the laboratory in the morning,—perhaps not at a very early hour,—the results must be handed in to the office before closing time. Indeed a well-known writer considers it "not surprising that the energies of scientific men have been taxed to devise new and rapid methods of chemical analysis to meet the wants of these high-pressure times." It is, of course, not the place to examine whether, having the game in their own hands, they might not better have pursued a different policy.

Another consequence—though it might have occurred independently—has been the development of volumetric analysis. Alkalimetry and acidimetry were, of course, known at an earlier date, but the extension of the principle to the majority of inorganic and some organic matters of commercial value falls well within the Victorian era. The entire volumetric method has been in some quarters brought into unmerited discredit by the mistakes of its earlier advocates, who, feeling satisfied that they had here processes which enabled them to dispense with tedious or delicate separations, often overlooked the influence of foreign bodies altogether. Thus in determining copper in ores and slags, by the well-known method of Parkes, the presence of cobalt, nickel, manganese, &c., was too often ignored. That we have now certain volumetric processes which are fairly comparable with the best gravimetric determinations, as far as accuracy is concerned, is a fact which needs no demonstration.

Colorimetry, a branch of volumetry, has grown into practical importance in the half century, in the hands of such chemists as Eggertz and Carnelley.

But we have a decidedly novel and plainly modern development of volumetry in gas analysis. The eudiometer was of course known and used in the last century, by Cavendish and others. But the systematic determination of a complex gaseous mixture is a thing of to-day. Without it we could have no useful knowledge of the gases within the lead-chambers or at different points of the blast-furnace. Thus the manufactures of sulphuric acid and of iron—the one the initial point of our chemical, and the other of our mechanical industries—are unspeakably indebted to volumetric gas analysis. Little less striking is its advantage in sanitary chemistry.

An entirely new departure belonging to the era in question is spectroscopic analysis, qualitative and quantitative. That infinitesimal quantities of certain methods can be detected by means of the spectroscope and its accessories,—*e.g.*, sodium even to the 1,400,000th of a m.grm.—is fully established.

Most of the rare earths are readily distinguished from each other by means of their spectra, a process which has the advantage of requiring merely an infinitesimal portion of material. But much remains to be done before the spectroscope becomes of general utility in quantitative research. Prof. Chandler Roberts has not found its indications useful for the assay of alloys of the precious metals, the great obstacle being the difficulty—we might say the impossibility—of obtaining indications fairly representative of the whole ingot.

Another great step has been the introduction of electrolytic analysis. In this manner many metals can be determined with remarkable dispatch, accuracy, and simplicity. In electrolytic methods the number of operations and the reagents used are minimised, and consequently the possibilities of error are reduced in a like proportion. As an excellent specimen of an electrolytic process we may mention the Mansfeld copper-assay. It becomes at least conceivable that even certain organic compounds may be separated from foreign matter by electric action, and isolated in a ponderable state. But this is a task which must be left for the next half century.

Blowpipe analysis has been very extensively developed in the hands of a number of chemists and mineralogists, of whom Plattner, Chapman, and Ross may perhaps be fairly singled out. The epoch-making feature here must be pronounced the applications of the blowpipe in quantitative determinations,—an innovation which will doubtless do much to restrict the field for furnace assays. That the Cornish copper-assay should have survived so long is a singular feature in the history of applied science. As far as gold and—to some extent—silver are concerned, cupellation still reigns supreme.

As one of the novelties of the Victorian era, and as one in which Britain has had the largest share, we must mention the analysis of waters, both for domestic and for industrial uses, as well as that of sewage and waste waters. In this department the name of Clarke stands prominent for the practical determination of hardness, whilst those of Frankland, Wanklyn, Tidy, and Leeds will be remembered for having rendered the estimation of organic dissolved matter possible, at least, with an approximate degree of accuracy.

If we may, in concluding this part of our subject, venture on a suggestion, we would point out that the human organs of scent are—according to the researches of Fischer and Penzoldt—capable of detecting certain substances with a degree of delicacy 250 times greater than that of the eye by means of the spectroscope. On the other hand, we know from our own experience, and from the testimony of friends, that odours, even in the absence of a scientific nomenclature, fix themselves in the memory far more vividly and tenaciously than do colours, forms, sounds, or even words. Perhaps there is here the germ of a new analytical method.

THE AIR OF SEWERS.*

By Professor CARNELLEY, D.Sc., and J. S. HALDANE, M.A., M.B., University College, Dundee.

OWING to the complaints which had been made of bad smells in the House of Commons a Select Committee was appointed in the spring of 1886 to inquire into the ventilation of the House. By that Committee the authors were instructed to make a series of analyses of the air in the sewers under the Houses of Parliament, and to report thereon. Since then they have examined a considerable number of sewers in Dundee, and have also made a number of laboratory experiments. The object of the research was to obtain a general idea of the amount of some of the more important impurities in sewer air, and to throw some light on their sources, and the conditions affecting their dissemination.

After giving a brief *résumé* of the results of the analyses which had been previously made of sewer air, the authors describe the methods they have employed, and the nature and condition of the sewers they have themselves examined.

As a result of their investigation they found—(1.) That the air of the sewers examined was in a much better condition than might have been expected. (2.) That the carbonic acid was about twice, and the organic matter rather over three times as great as in outside air at the same time, whereas the number of micro-organisms was less. (3.) That in reference to the *quantity* of the three constituents named the air of the sewers was in a very much better condition than that of naturally ventilated schools, and that with the notable exception of organic matter it had likewise the advantage of mechanically ventilated schools (*cf.* paper by the authors and Dr. Anderson in *Phil. Trans.*, 1887). (4.) That the sewer air contained a much smaller number of micro-organisms than the air of any class of house, and that the carbonic acid was rather greater than in the air of houses of four rooms and upwards, but less than in two- and one- roomed houses. As regards organic matter, however, the sewer air was only slightly better than the air of one-roomed houses, and much worse than that of other classes of houses. (The data for all the classes of houses refer to sleeping rooms when occupied during the night.)

The amount of carbonic acid found by the authors was much less than that noted by earlier observers, showing that the sewers they examined were much better ventilated than those previously investigated.

On taking the average of a comparatively large number of analyses it was found that the quantity of organic matter in sewer air increased with the carbonic acid, whereas the micro-organisms on the whole decreased with increase of the other constituents.

With regard to the sources of the several impurities in sewer air the following conclusions are drawn:—(1.) The *carbonic acid* in excess of outside air may be partly due to diffusion from the neighbouring soil, but its chief source is probably the oxidation of the organic matter in the sewage and in the air of the sewer. (2.) The *organic matter* in excess of outside air is most probably wholly or for the most part gaseous, and is of course derived from the sewage itself. (3.) The *micro-organisms* in sewer air come entirely, or nearly so, from the outside, and are not derived, or only in relatively small numbers, from the sewer itself. This is proved by the following facts:—*First*, the average number of micro-organisms in sewer air was less than in outside air at the same time—viz., about 9 in the former to 16 in the latter. *Second*, the number increased with the efficiency of the ventilation. *Third*, the average proportion of moulds to bacteria in sewer air was almost exactly the same as in outside air at the same time, whereas one would expect the proportion to be very different were the outside air not the source from which they were derived, seeing that such a difference has been proved to exist in the air of houses, schools, &c. *Fourth*, the naked eye appearance of the colonies from sewer air is similar to that of those from ordinary air. *Fifth*, the state of filthiness of a sewer seems to have no perceptible effect on the number of micro-organisms. *Sixth*, the view that the micro-organisms in sewer air chiefly come from outside is in perfect agreement with what is known as to the distribution of bacteria in air. *Seventh*, results obtained in the laboratory with an experimental sewer prove that the micro-organisms present in air are diminished to nearly one-half in passing along a moist tube 5 feet long and 1¾ inches in diameter at a rate of nearly 1 foot per second, Although most of the micro-organisms in sewer air come from outside, yet there was distinct evidence of their occasional dissemination from the sewage itself. This is the case when splashing occurs, owing to drains entering the sewer at points high up in the roof. It is, therefore, of great importance that drains should be so arranged as to avoid splashing as much as possible.

In view of the fact that ordinary sewer air is to all appearance comparatively innocent as regards its micro-organisms, experiments were also made to see whether it contained any poisonous volatile base of the nature of a ptomaine. These experiments so far as they went had negative results.

Experiments as to the efficacy of ordinary water traps in preventing the escape of sewer gas into houses confirmed and extended the results previously obtained by Fergus.

Though the authors do not discuss the effect of the inhalation of sewer air on health, yet the results of the above investigation are clearly such as to make one much more suspicious as to supposed evidence of the bad effects of ordinary sewer air (at least when not vitiated by splashing), such as that examined by them.

* Abstract of a Paper read before the Royal Society, June 16, 1887.

ON DIAMIDE (HYDRAZINE) (N_2H_4).

By THEODOR CURTIUS.

By treating diazoacetate of ethyl with a hot concentrated solution of caustic potash, the potassium salt of a new diazo-acid of the fatty series is produced, crystallising in large yellow prisms. This salt differs from other diazo-compounds of the fatty group by not evolving nitrogen on addition of an acid to its aqueous solution, and by separating out unchanged in glittering yellow plates. I am still engaged, along with J. Laing, in investigating this interesting body. I wish here, however, to direct attention to the remarkable change produced when it is heated with dilute sulphuric acid. The yellow colour disappears, no nitrogen being evolved, and, on cooling, fine colourless crystals separate.

These crystals are the sulphate of the long sought for base, diamide; owing to the sparing solubility of this salt in cold water, it is easily obtained pure. Its formula is $N_2H_4.H_2SO_4$.

The hydrochloride, $N_2H_4.2HCl$, is prepared from the sulphate by addition of barium chloride. It is easily soluble in cold water, but sparingly in hot alcohol. Both these salts decompose suddenly when heated. The sulphate is partly reduced with separation of sulphur. The hydrochloride does not form a double salt with platinic chloride.

Free diamide may be obtained by heating its salts with alkalies. It is a gas which, when mixed with much air, has little smell; but concentrated, it attacks nose and throat, yet has little resemblance to ammonia. It is easily soluble in water, turns red litmus blue, and when not too dilute, forms clouds with aqueous hydrochloric acid.

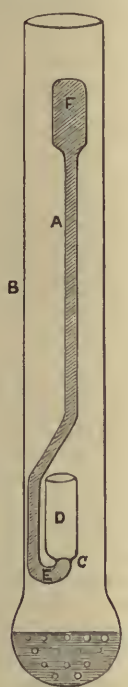
It is a powerful reducing agent, at once decomposing Fehling's solution and ammoniacal silver nitrate. With neutral copper sulphate it gives a red precipitate; the hydrate is precipitated from salts of aluminium, and with mercuric chloride it produces a white precipitate. With

aromatic aldehyds and ketones sparingly soluble crystalline bodies are formed. The solutions of its salts evolve nitrogen on treatment with nitrous acid.

AN APPARATUS FOR DETERMINING VAPOUR DENSITIES.

By D. S. MACNAIR, F.C.S., A.I.C.,
Lecturer on Chemistry in Allan Glen's Institution, Glasgow.

Of all the methods of determining vapour densities which have come into general use, that of Hofmann is the only one in which the substance is volatilised under diminished pressure. This method, as is well known, has great advantages over all others, especially in the case of unstable bodies, which would decompose at the temperatures required to vapourise them under the ordinary atmospheric pressure. Unfortunately Hofmann's apparatus is somewhat complex and expensive, and for this reason his



method is now but little used. The apparatus which I have devised, and which is shown in the sketch, is essentially a modification of Hofmann's, and will, I think, be found to combine most of its advantages, including at least equal accuracy, with the addition of great simplicity. The apparatus consists of two parts—(1) a syphon barometer tube, A, and (2) an outer tube, B, as in V. Meyer's apparatus. The tube, A, is filled with mercury to the point C. The weighed quantity of substance (20 to 100 m.grms.) in a small stoppered tube is introduced into D, and then, by means of a bent glass rod, is pushed under the surface of the mercury and round the bend, E, whence it rises, through A, into the widened part, F. The tube, A, is now suspended by a wire in the outer tube, B, and the liquid in B (which may be water or any other liquid of known and constant boiling-point) is heated. It is well to loosely close the mouth of B with a cork to prevent the access of air. The liquid in F is soon converted into vapour, and the mercury falls. As soon as its level becomes constant, the difference in level between the mercury in the two limbs of A is read off, best by means of a pendulum cathetometer. The other data required are (1) the barometric pressure, (2) the boiling-point of the liquid used in B, (3) the volume of the vapour in A. The last may be got in various ways; in my own experiments I used an india-rubber ring which could be moved up or down the narrow part of A by means of a bent wire. This being brought to the level of the mercury, the volume of the vapour was found, after cooling, by filling A with mercury to the height of the ring, and then weighing or measuring the mercury. The vapour density is then calculated exactly as in Hofmann's method. I give the details of an actual experiment—

Vapour density of toluene (b. p., 111°) in steam.

Weight of substance used	0·0262	grm.
Height of mercury column (at 100°)	428	m.m.
Barometer (at 20°)	750·5	,,
Volume of vapour	20·0	c.c.
Vapour density found	46·3	,,
,, ,, calculated	46·0	

I hope to be able to publish fuller particulars of the method in a few weeks, after I have had time to test it more thoroughly.

FLUORIDE OF NITROGEN.

By H. N. WARREN, Research Analyst.

The supposed compound was formed by passing an electric current from seven ferric chloride batteries through a concentrated solution of ammonium fluoride. After the lapse of a short time several drops, of oily consistence, were observed attached to the negative plate. On becoming connected with the positive, a thin gold wire, these drops exploded with great violence. The compound is undoubtedly highly unstable, being at once decomposed in contact with glass, silica, or organic matter, thus rendering the analysis of the same one of considerable risk. Its explosive violence is even greater than the chloride of nitrogen, and it is also prone to spontaneous decomposition.

VOLUMETRIC ESTIMATION OF ALUMINA.

By RICHARD GATENBY.

This can be done with great facility when it is contained in caustic soda. Take first the amount of caustic soda present with normal HCl acid and phenol-phthalein as indicator. When the phenol-phthalein is decolorised we have the amount of caustic soda present. Then put into it a few drops of methyl orange solution and again add normal HCl, stirring well (not heating) until a pink colour is obtained which does not vanish by stirring for a few seconds. The number of c.c. of normal HCl required by the second titration equals amount of alumina and alkaline soda salts present. Then add litmus solution, and titrate back with normal caustic soda until a decided blue colour appears.

Each c.c. of normal caustic soda required = 0·0257 of alumina.

A sample of caustic soda bottoms from 70 per cent white caustic soda, called by the trade 68 per cent bottoms, tested as follows:—

Na_2O	57·1
H_2O	16·5
Na_2CO_3, &c.	2·4
Al_2O_3	11·3
Insoluble Fe_2O_3, &c.	12·5
	99·8

This process is very rapid, and accurate enough for technical use. It is a strange fact that alumina is alkaline to methyl orange, and acid to litmus solution.

5, Petworth Street, Cheetham,
Manchester, June 11, 1887.

A METHOD OF SEPARATING THE TWO ISOMERIC TOLUIDINE-SULPHONIC ACIDS.

By E. A. SCHNEIDER.

WHILE working with the toluidine-sulphonic acids for the purpose of making the hydrazine-sulphonic acids used in the above experiments, I made the observation that the potassium salt of *p*-toluidine-*m*-sulphonic acid, which is very easily soluble in water, is insoluble in cold caustic potash, while the potassium salt of *p*-toluidine-*o*-sulphonic acid is extremely easily soluble in the same liquid at ordinary temperature. The same is true of the corresponding sodium salts. If it is desired to separate a mixture of the two acids into its components it is only necessary to heat it with concentrated caustic potash until it has all passed into solution. If this solution is allowed to cool slowly, the potassium salt of *p*-toluidine-*m*-sulphonic acid crystallises out in stout needles, which can be easily separated from the mother-liquor by means of a platinum cone and a filter-pump. It is advisable to wash the salt in the funnel with alcohol and then quickly to press it between layers of filter-paper. —*American Chemical Journal*, Vol. viii., p. 4.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING MAY 31ST, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To THE WATER EXAMINER, *Metropolis Water Act*, 1871.

London, June 4th, 1887.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from May 1st to May 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

During the past month, despite the prejudicial influence of the stormy weather on the state of the river sources, the general character of the water supplied to the Metropolis has been eminently satisfactory. The proportion of organic matter present in the water—not at any period of the year excessive—has, with the advance of the season, undergone an appreciable diminution. Thus, in the case of the Thames-derived supply, the maximum proportion of organic carbon in any one sample was 0·152 part in 100,000 parts of the water; while the mean proportion for the month was 0·134 part, as against a mean of 0·162 part for the preceding month, and a mean of 0·167 part for the previous four months of the year.

As during last month, several samples of the East London Company's Lea-derived supply were found wanting in freedom from turbidity and tint of ochrey colour, consequent not on imperfect filtration of the water, but on special treatment to which the mains of the Company are now being subjected. The condition of this Company's water, in respect to its degree of freedom from organic matter, was, however, unexceptionable, the mean proportion of organic carbon present being only 0·108 part, with a maximum of but 0·131 part in 100,000 parts of the water.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

METHODS FOR DETERMINING THE RELATIVE STABILITY OF THE ALKYL BROMIDES.*

By IRA REMSEN and H. W. HILLYER.

(Concluded from p. 282).

Action of Ammonia on Normal and Isopropyl Bromides.

THE marked differences between the stability of propyl bromide and that of isopropyl bromide led to the examination of their conduct towards other reagents than those used in the experiments already described. The first one used was ammonia. Standard solutions were made by dissolving 3·8437 grms. of each bromide in 250 c.c. alcohol. Each c.c. of this solution contained 10 m.grms. of bromine. The substances were weighed in tubes of about 8 by 180 m.m. drawn out to a point. One of these, after a file-scratch was made on it near the point, was placed on the balance-pan in an upright position in a small beaker. After weighing, weights amounting to 3·8437 grms. were added to the other pan, and enough of the bromide was run in, by means of a narrow glass tube drawn to a point and used as a pipette, to bring again to a balance. It is not difficult, after a little practice, to weigh in this manner to within a m.grm. The point of the weighing tube, being thrust into the mouth of a 250 c.c. measuring flask, was broken off by pressing it against the inside of the neck of the flask. After the bromide had run out, the tube was immediately rinsed out by pouring alcohol through it. The flask was then filled to the mark with alcohol, and, after thorough mixing, the contents were transferred to tightly stoppered bottles. To 20 c.c. of each of the solutions, 20 c.c. of aqueous ammonia of 10 per cent were added. At the end of about twenty hours the bromine extracted was found to be, in the case of normal propyl bromide, 25·4 m.grms. in one flask and 29·2 m.grms. in another; in the case of isopropyl bromide, 3·8, 4·2, and 5·0 m.grms. in three flasks.

From these results it is clear that normal propyl bromide is much more rapidly decomposed by ammonia than isopropyl bromide. As shown by the experiments above recorded, caustic soda alone extracted 9·8 and 11·9 m.grms. of bromine from normal propyl bromide, while in parallel experiments it extracted only 5·6 and 4·9 m.grms. of bromine from isopropyl bromide.

Action of Alcoholic Sodium Hydroxide on the Alky Bromides.

By way of supplementing the experiments described above, in which the action of sodium hydroxide on the bromides was studied, a more extended series of similar experiments was now undertaken. In each flask there

* *American Chemical Journal*, vol. viii., p. 251.

were placed 20 c.c. bromide solution, containing in all 200 m.grms. of bromine, 10 c.c. alcohol, and 20 c.c. caustic soda solution, made by the action of water on sodium amalgam, and containing about 10 per cent sodium hydroxide.

Of the 200 m.grms. of bromine in each flask the following quantities were extracted :—

Ethyl..	165·6	or 82·8 per cent.
,, ...	159·2	79·6
N. propyl.. ..	130·5	65·2
I. propyl	50·4	25·2
Butyl..	31·2	15·6
,, ...	32·2	16·1
Amyl..	65·8	32·9
,, ...	67·6	33·8

These results confirm those already obtained, and indicate clearly that fairly satisfactory results may be expected by a similar comparison of other alkyl bromides with reference to their stability towards caustic soda. The reaction which takes place with this reagent is in all probability represented by the equation—

$$C_nH_{2n+1}Br + C_2H_5OH + NaOH = C_nH_{2n+1}.O.C_2H_5 + KBr + H_2O.$$

That is, a mixed ether containing ethyl and the radical of the bromide used is formed in each case. In the above experiments the odour of common ether was unmistakable in the flask with ethyl bromide. In the flask with propyl bromide there was also a pleasant odour like that of common ether, and quite different from that of the bromide solution. An experiment was performed in which a larger but unknown quantity of normal propyl bromide was treated with caustic soda and alcohol. After standing a week or two the mixture was made neutral with nitric acid, and subjected to distillation, when a small quantity of a volatile liquid was obtained, which had an odour very much like that of common ether and a density less than that of water. The quantity was so small that the boiling-point could not be determined. Several cases are known* in which mixed ethers have been formed by treating halogen derivatives of the hydrocarbons with alcoholic potash at an elevated temperature, but the reaction has not been supposed to take place as easily as we have found it at the ordinary temperature.

Action of Soluble Silver Salts on the Two Propyl Bromides.

Preliminary experiments having shown that silver nitrate slowly decomposes the bromides, its action on the two propyl bromides was next tried.

Twenty c.c. normal propyl bromide solution, 5 c.c. dilute nitric acid, and 25 c.c. solution of nitrate of silver, containing silver equivalent to 25 m.grms. bromine, were put in a flask and allowed to stand for sixteen hours in a dimly lighted place. At the end of this time there were considerable opalescence and some deposition of silver bromide. By titration it was found that 2·7 m.grms. of bromine had combined with silver. A similar mixture containing isopropyl bromide was found to have deposited a heavy, yellowish white precipitate of silver bromide. On titration it was found that, of the 25 m.grms. of bromine with which the silver added was capable of combining, 24·3 m.grms. were thus combined.

From a solution containing 20 c.c. bromide solution, and 20 c.c. of a neutral solution of silver acetate, capable of precipitating 20·2 m.grms. bromine, 19·2 and 19·2 m.grms. bromine were found precipitated in two parallel experiments with the isobromide, while only 2·5 and 2·5 m.grms. were precipitated in parallel experiments with the normal bromide.

The isopropyl bromide is decomposed much more readily by silver nitrate and by silver acetate than normal propyl bromide. Towards silver salts, therefore, these two bromides act in the same way that they do towards zinc and sulphuric acid.

Action of Cobalt Zincs and Acetic Acid on Alkyl Bromides.

Mixtures were made containing 20 c.c. bromide solution and 10 c.c. acetic acid of ordinary strength. These were allowed to act for two hours and twenty minutes on six cobalt zincs prepared as above described. In the case of the normal bromide 2·0 and 1·9 m.grms. of bromine were set free in two different flasks. In the case of the isobromide the quantities of bromine set free were 8·0 and 8·1 m.grms. By adding sufficient nitric acid all of the red ferric acetate formed by adding the ferric sulphate may be changed to the colourless nitrate, so that the titration by Volhard's method presents no difficulties. The action of the mixture of alcohol and acetic acid on the cobalt zincs gives a very regular evolution of hydrogen, which, though not rapid, may be continued for five or six hours before the zinc acetate begins to crystallise out.

The form of the zincs was now changed to that of a flat spiral, made by winding a strip of zinc one-half inch by 24 inches about a small core, then unwinding and loosening the coil till no two turns were in contact. The coil was placed in a beaker which contained the solution of the bromide to be reduced, and a small glass rod, so bent as to make a support for the coil, thus ensuring free circulation.

In one series of experiments in which the action was kept up for about five hours, the normal bromide yielded 4·5 and 4·8 m.grms. bromine, and the isobromide 20·0 and 20·1 m.grms. bromine.

Finally, a series of experiments was made including the five bromides. For this purpose standard solutions were made containing equivalent weights of the bromides, so that 1 c.c. of each solution contained the same number of m.grms. of bromine, the concentration being the same as that of the propyl bromides—viz., 20 c.c. of each solution containing 200 m.m. of bromine. The conditions as regards quantity of bromide, of alcohol, and of acid, were the same as in the last case. The zincs, however, were different. At the end of five hours titration gave the following results :—

Bromide.	M.grm. Br set free. I.	II.
Ethyl	1·2	1·5
N. propyl..	3·3	3·3
I. propyl	10·5	11·7
Butyl	6·0	6·0
Amyl..	9·0	9·9

It was afterwards found that, by standing in alcoholic solution alone, butyl and amyl bromides are slightly decomposed, so that the above figures for these bromides are somewhat too large.

As was stated at the beginning of this paper, the object of the investigation was to determine which of the various methods which suggest themselves for the purpose of measuring the relative stability of the alkyl bromides are most likely to yield results of value. It seems that the action of zinc and acids is not capable of giving very reliable results, though the general tendency of the action can easily be determined. The action of zinc in alkaline solution is so complicated by the independent action of the alkali alone that it is of little value. In the same way the action of sodium amalgam is also complicated by the fact that the solution constantly grows more and more alkaline. On the other hand, the action of salts of silver on fairly concentrated solutions of the bromides promises good results, as does also the action of ammonia and of caustic soda alone. It is proposed, as soon as possible, to study the reactions with care, using as large a number of bromides as may be obtainable. Among experiments already performed by others, and having some relation to

* *Annales de Chimie et de Phys.* (3), xii., 302 ; *Jahresbericht*, 1850, 560; *Philosophical Magazine* (4), xiv., 186; *Annalen der Chemie*, xcii. 351; *Journal of* (London) *Chemical Society*, xix., 358.

those described in this paper, the following should be mentioned :—

Wislicenus,* by treating various haloid ethers with the sodium compounds of aceto-acetic ester, ethyl aceto-acetic ester, and malonic ester without external application of heat, found the order of stability of some alkyl bromides and iodides. In the order of increasing stability he placed the compounds experimented upon thus : —Methyl iodide, ethyl iodide, primary propyl iodide, ethyl bromide, primary isobutyl iodide, primary propyl bromide, tertiary butyl bromide. Or, taking the iodides alone :— Methyl, ethyl, primary propyl, isopropyl, isobutyl. This is the same order as that observed in the series of experiments with alcoholic caustic soda.

Jackson† studied the relative stability of certain substituted benzyl bromides. By the action of a solution of sodium acetate in alcohol on the ortho-, meta-, and para-brom-benzyl bromides at 100°, he found that the ortho-bromide is the most stable towards this reagent, the meta next, and the para the least stable.

THE INDIRECT ESTIMATION OF CHLORINE, BROMINE, AND IODINE BY THE ELECTROLYSIS OF THEIR SILVER SALTS.

With Experiments on the Convertibility of the Silver Salts by the Action of Alkaline Haloids.

By J. EDWARD WHITFIELD.

In the absence of reliable methods for the direct quantitative separation of bromine and chlorine, it is usual to employ one or other of the methods for the conversion of the mixed silver salts to a common condition.

Both the reduction to silver by hydrogen and the conversion of the bromide to chloride by heating in an atmosphere of chlorine are attended with loss by volatilisation and mechanical transfer, and the possible inaccuracy of both the processes is such that they can scarcely be considered as available for the estimation of small amounts of either constituent in presence of large amounts of the other.

Of all such methods the electrolytic analysis of the mixed and fused silver salts, as proposed by Bolley,‡ and more recently introduced and tested by Kinnicutt,§ is probably the best, though, according to Finkener‖, perfect decomposition is difficult to obtain by this method, and there is danger of volatilisation and partial change of the silver salts in the fusion.

Kinnicutt's test analyses of the fused salts show, for silver chloride and silver bromide each by itself, errors of 0·0006 grm. — to 0·0003 grm.+ on amounts varying from 0·7 grm. to 1·8 grms.; and for the mixed silver chloride and bromide, errors from 0·0010 grm.— to 0·0012 grm.+, with a mean of 0·0006 grm.+ on weights varying from 2 grms. to 2·8 grms.

These figures represent the sum of the errors from the weighing of the fused chloride to the weighing of the deposit of silver, and do not include errors made in the precipitation, filtration, transfer to crucible, and fusion.

A method in which the decomposition of the silver salts may be effected without fusion, and which would at the same time place the errors of filtration, preparation for weighing, and subsequent electrolysis at a minimum, seems to be desirable, and a promising line of investigation was suggested by Luckow's assertion¶ that from the solution of silver chloride in potassium cyanide the silver may be thrown down completely.

Luckow gives no figures excepting a common mean of all determinations by the precipitation from the cyanide solution and the decomposition of the solid chloride on the negative pole of the battery under sulphuric acid, so that the first experiments were made to test the accuracy of the battery process under these conditions.

In experiments (1)-(5) silver chloride was the starting-point. In (1)-(3) the freshly precipitated and carefully washed chloride was dried to a constant weight in a platinum dish, protected from the light, at a temperature of about 150° C., dissolved in potassium cyanide, and electrolysed after the addition of a little sodic hydrate, preliminary analyses having seemed to indicate that the presence of sodic hydrate affected the deposition favourably. In all subsequent experiments ammonia, which was found to be of equal service, was used instead of sodic hydrate.

In experiments (4) and (5) the chloride was converted, previous to electrolysis, into the bromide by solution in potassium cyanide, the addition of potassium bromide and precipitation by sulphuric acid as will be described later, and the precipitate re-dissolved in potassium cyanide, the object being to test the action of the battery upon the cyanide solution of the silver bromide.

	AgCl taken.	Silver found.	Silver calculated.	Error.
(1)	0·1565 grm.	0·1177 grm.	0·1178 grm.	0·0001 grm. —
(2)	1·3004	0·9785	0·9787	0·0002 —
(3)	2·2657	1·7047	1·7051	0·0004 —
(4)	0·7472	0·5618	0·5624	0·0006 —
(5)	0·2854	0·2133	0·2147	0·0014 —

These results, as far as they go, are satisfactory. Similar tests upon the electrolysis of silver bromide and silver iodide in the cyanide solution were undertaken, but it was thought advisable to combine, incidentally with the tests of the battery process, an examination of the method recently proposed by Maxwell-Lyte* for the direct conversion of silver chloride to the bromide and thence to the iodide.

Field† was the first to propose a quantitative conversion of silver chloride to the bromide by digesting the former in potassium bromide, and the change of the chloride or bromide to the iodide by the action of potassium iodide upon these salts. This method has been variously criticised and finally abandoned as an accurate process,‡ though, so far as concerns the conversion of the chloride and bromide to the iodide, Siewert§ shows it to be exact.

Maxwell-Lyte's method of proceeding, depending upon identically the same principle which Field attempts to utilise, consists in the solution of the silver haloid salts in potassium cyanide, the addition of potassium bromide, the decomposition of the potassium cyanide by means of sulphuric acid, with the consequent precipitation, and weighing of the silver bromide mixed with the iodide of the original mixture—the resolution of this precipitate in potassium cyanide, the addition of potassium iodide, the decomposition of the cyanide as before, with sulphuric acid, with the formation of a precipitate which is presumably pure silver iodide and to be weighed as such.

To convert the chloride to the bromide Maxwell-Lyte uses a weight of potassium bromide equal to the weight of the silver chloride taken; and to change the bromide to the iodide, a weight of potassium iodide one and a quarter times as great as the original weight of the silver chloride.

In the following experiments these amounts have varied widely, but the proportions of alkaline haloid salts employed are given for each case in the tabular statement.

The starting point was generally freshly precipitated silver chloride, but in the last three cases, pure silver, this being dissolved in nitric acid, precipitated with potassium bromide (two equivalents), and the precipitate dissolved in potassium cyanide, converted into the iodide in the manner described, and weighed, the object of this being to test the convertibility of the silver bromide to silver iodide.

* *Annalen der Chemie*, ccxii., 239.
† *Amer. Chem. Journ.*, iii., 252.
‡ *Dingl. Pol. Jour.*, cli., 46.
§ *American Chemical Journal*, iv., 22.
‖ Rose-Finkener, "Quant Anal.," ii., 621.
¶ *Dingl. Pol. Jour*, clxxviii., 43.

* Chem. News, xxxxix., 3.
† *Jour. Chem. Soc.*, x., 234.
‡ Rose-Finkener, *loc. cit.*
§ *Zeit. für Anal. Chem.*, vii., 469.

	AgCl taken.	AgBr found.	AgBr calculated.	Error.		Equivalents of KBr taken.
(6)	0·3260 grm.	0·4227 grm.	0·4270 grm.	0·0043 grm.	−	2
(7)	0·3093	0·4023	0·4052	0·0029	−	2
(8)	1·3801	1·8041	1·8080	0·0039	−	2
(9)	0·2091	0·2723	0·2739	0·0016	−	10
(10)	0·6846	0·8909	0·8968	0·0059	−	10
(11)	1·1625	1·5202	1·5230	0·0028	−	20
(12)	1·1734	1·5310	1·5372	0·0062	−	20
(13)	0·3501	0·4553	0·4586	0·0033	−	29
(14)	0·4178	0·5468	0·5473	0·0005	−	29

	AgCl taken.	Silver found.	Silver calcula ed.	Error.	
(6)	0·3260 grm.	0·2443 grm.	0·2453 grm.	0·0010 grm.	−
(7)	0·3093	—	—	—	
(8)	1·3801	1·0385	1·0386	0·0001	−
(9)	0·2091	—	—	—	
(10)	0·6846	0·5137	0·5152	0·0015	−
(11)	1·1625	—	—	—	
(12)	1·1734	0·8829	0·8831	0·0002	−
(13)	0·3501	0·2634	0·2634	0·0000	
(14)	0·4178	—	—	—	

	AgCl taken.	AgI found.	AgI calculated.	Error.		Equivalents taken of KI.
(15)	0·6996 grm.	1·1451 grm.	1·1456 grm.	0·0005 grm.	−	2
(16)	0·7587	1·2429	1·2424	0·0005	+	2
(17)	0·6710	1·0992	1·0988	0·0004	+	10
(18)	0·2515	0·4118	0·4118	0·0000		10
(19)	0·6501	1·0646	1·0646	0·0000		10

	AgCl taken.	Silver found.	Silver calculated.	Error.	
(15)	0·6996 grm.	0·5255 grm.	0·5265 grm.	0·0010 grm.	−
(16)	0·7587	0·5691	0·5710	0·0019	−
(17)	0·6710	0·5042	0·5050	0·0008	−
(18)	0·2515	0·1892	0·1892	0·0000	
(19)	0·6501	0·4892	0·4892	0·0000	

	Silver taken. Grm.	AgI found. Grm.	AgI calculated. Grm.	Error. Grm.	Equivalents taken of KI.	Silver found. Grm.	Error. Grm.
(20)	0·5418	1·1790	1·1789	0·0001 +	2	0·5417	0·0001 −
(21)	0·3750	0·8154	0·8159	0·0005 −	2	0·3746	0·0004 −
(22)	0·4078	0·8859	0·8873	0·0012 −	10	0·4077	0·0001 −

In most cases the final precipitate, after weighing, was electrolysed, so as to have a more perfect control upon the results of the conversion process, and at the same time to test the battery method additionally.

The bromide and iodide of silver were precipitated hot from dilute solutions, which were cooled and allowed to stand over night to settle before filtering.

Filtrations were made by the use of the Gooch crucible, with gentle pressure; the silver salts were dried directly over a low Bunsen flame at a temperature far below the melting-point, and dissolved, after weighing, by introducing crucible and asbestos into a strong solution of potassium cyanide, and heating, the time necessary for the solution varying from a few minutes to several hours, according to circumstances.

In some cases traces of reduced silver were found with the asbestos, and were recovered by treating the felt with nitric acid and washing, the filtrate and washings being added to the main solution.

The deposition of silver was made in the platinum dish of 100 c.m.³ capacity, which held the solution, and the current found most suitable was (as Luckow originally recommended*) developed by four Meidinger cells of large size.

With solutions of the volume named and the area of the negative electrode employed, it was found advisable not to attempt to treat more than 2 grms. of the silver salt.

The solution was decanted immediately on the stopping of the current, or better, syphoned off while the battery connections were still unbroken, and washed with distilled water, to prevent the solvent action of the cyanide on the deposit.

From these experiments it appears that the deposition of silver from the cyanide solution of the chloride, bromide, or iodide is exceptionally exact; the tendency of the process, however, is to yield low results, and yet, in spite of the multiplicity of operations through which the original material has been passed in the attempt to settle two questions at once, the deficiency is not very great, being 0·0005 grm. in the mean of eighteen determinations, with a maximum value of 0·0019 grm.

The conversion of silver chloride to silver bromide by the method proposed by Maxwell-Lyte is, like its predecessor, too imperfect to be worthy of trust; but the experiments indicate unmistakably that the change of silver chloride or silver bromide to silver iodide is sufficiently complete to afford the basis of a good analytical method.

The indirect estimation of chlorine and bromine, chlorine and iodine, or bromine and iodine, in presence of one another, may be effected satisfactorily, therefore, by precipitating both together as silver salts, filtering on abestos, washing, drying, at 150° C., weighing, dissolving the residue in potassium cyanide, and either electrolysing the solution to determine the silver or precipitating the silver as iodide, again filtering upon asbestos, washing, drying, and weighing.

In a mixture of all these halogens the iodine is first to be separated by known methods and the chlorine and bromine indirectly estimated as described. — *American Chemical Journal*, Vol. viii., No. 6.

* *Loc. cit.*

NOTICES OF BOOKS.

The Artificial Organic Colouring-Matters. Based upon Six Lectures delivered by Prof. E. Noelting at the "Ecole de Chimie," in Mulhouse. Edited by Dr. Paul Julius. (Die künstlichen organischen Farbstoffe. Unter Zugrundlegung von sechs Vorlesungen gehalten von Prof. Dr. E. Noelting, Director der "Ecole de Chimie" in Mühlhausen, bearbeitet von Dr. Paul Julius). Berlin: R. Gaertner.

We may fitly begin our notice of this useful little work with the announcement that, according to a recent decree, all instruction at the Ecole de Chimie is to be given exclusively in the German language. Dr. Noelting's lectures have already appeared in the *Moniteur Scientifique*, but in the book before us they have been enlarged and in some respects apparently re-modelled, though with the consent and co-operation of the lecturer.

The first chapter of this work is devoted to a general account of coal-tar and its more important constituents. The author remarks that coal-tar, once a worthless and troublesome by-product, has become a valued and remunerative article of commerce. But we must not forget that the "whirligig of time" has brought on another change: coal-tar, despite the progress of the colour-industry, is again a drug in the market, so that the managers of gas-works are often glad to burn it under their retorts in partial substitution for coke.

In the second chapter Dr. Noelting discusses the intermediate products,—substances obtained from coal-tar and employed in the manufacture of colours, but not having any tinctorial properties, such as aniline, the toluidines, phenol, resorcine, phthalic acid, &c.

The third chapter gives a very clear summary of Witt's researches on the circumstances of the conversion of aromatic hydrocarbons into true colouring-matters. The author enumerates those radicles to which Witt has given the name of "chromophorous groups," which by their introduction generate chromogenes, and he shows how the latter again are transformed into colouring-matters by means of the halogenous groups, the amidic and the hydroxylic.

There follows a brief account of the process of dyeing. The author inclines to the chemical theory rather than the mechanical, and cites phenomena which tell strongly in favour of the former view.

Thus if a skein of silk is steeped in a solution of the (colourless) rosaniline base, and heat is applied, the skein is dyed as full a red as if a salt of rosaniline had been present. We can only understand this fact if we admit that the rosaniline base unites with the fibre to form a salt, and consequently plays the part of an acid.

Prof. Noelting does not, however, seek to overlook the arguments which may be brought forward against the chemical theory. For the facts that cotton fibre, a substance chemically indifferent, is dyed by curcumine (from turmeric), and by the carthamine (of safflower), no explanation has hitherto been produced.

We cannot help considering that this third chapter will prove priceless to all technical students who wish to devote themselves to the tinctorial arts or to the manufacture of colours. We even know of experienced practical men who might study it with great advantage.

The classification of the colouring-matters adopted rests on the chromophorous groups present in each case. We have thus, 1, the nitro- and nitroso-colours; 2, the azo-class (or, as the French persist in calling them, the azoïc group, a term pre-engaged); 3, the triphenylmethan colouring-matters; 4, the phthaleines; 5, artificial indigo; 6, the anthracenes; 7, the chinoline and acridine colours; 8, the indophenols, indamines, and Lauth's colours; 9, the azines, eurhodines, and saffranines; 10, the indulines and nigrosines; 11, aniline black; and 12, galloflavine, canarine, and cachou de Laval, which form an Appendix

These classes are then described in a series of chapters. We may, perhaps, take justifiable exception to the introduction here of indigo. The artificial product is absolutely identical with natural indigo, and is little more than a curiosity. The author admits, in his historical introduction, that "artificial indigo is not in a position to compete with the natural product, and the probability that it will ever become so is very trifling." That probability, or rather possibility, has since been greatly diminished by the introduction of the new "ammonia process" in some factories in India. Not only is the working simplified, but at Tirhoot an increased yield of some 40 per cent has been obtained. Hence the planter will be able to reduce his prices without loss, and the difficulty which synthetic indigo encounters in competing with the natural product will be greatly increased.

One of the first reflections which suggest themselves to the reader is the number of artificial colouring-matters which have fallen into disuse, partial or entire. As such we notice isopurpuric acid, Victoria orange, aurantia, heliochrysine, amido azobenzol, phosphine, aldehyde green, coralline, azuline, hexaoxymethyl aurine, resorcine-benzeine, &c. Even the eosines have been to a very great extent superseded by azo-dyes.

With a note on p. 41 we are quite unable to agree. Says the author—"The custom of mixing colouring-matters for sale with indifferent substances, such as sodium sulphate or chloride, magnesium sulphate or dextrine, is not to be regarded as sophistication." Now the dyer and the tissue printer are not practically inconvenienced by the presence of a small percentage of dextrine. But supposing colours so treated are used for the manufacture of so-called aniline inks. The great advantage of such inks is that they contain no gummy matter, and therefore dry instantly and leave no deposit on the pen. But if dextrine is present this advantage is sacrificed.

In the tenth chapter the author describes certain bodies which are certainly obtained from coal-tar, but which have no tinctorial properties, such as kairine, thalline, antipyrine, and saccharine.

Concerning the last-mentioned product he emphasizes the fact that it is not a food, and can therefore scarcely be thought of as a substitute for sugar. We find no reference to Prof. Ira Remsen's claim to the discovery of this compound.

The absolutely innocuous character ascribed to salicylic acid may very safely be called in question.

In the last chapter figure murexide (now merely of historical interest), galloflavine (which has a doubtful future on account of its want of permanence to light), the "patent colours" of Croissant and Bretonnière (known in France as "cachou de Laval"), and canarine (which is very fast, but not beautiful).

This work demands our almost unqualified approval, and may be warmly recommended to all tinctorialists who can read German.

A New Basis for Chemistry: a Chemical Philosophy. By Thomas Sterry Hunt, M.A., LL.D. (Cantab.). Boston: Cassino. London: Trübner and Co.

This work, though it deserves and will well repay a most careful study, is liable to be viewed in many quarters as heretical. The author repudiates the introduction of the atomic hypothesis into chemistry, though fully admitting definite combination by weight and by volume. He views chemical union as "an identification not only of the volumes (interpenetration mechanically considered), but of the specific characters of the combining bodies, which are lost in those of the new species." He says again:—"Nature builds up her units by interpenetration and identification, and not by juxtaposition of the chemical elements."

With Oken, whose influence we recognise throughout his teachings, he accepts the production of the chemical

elements from a primal undifferentiated matter, "Urstoff" or "protyle."

He complains of the tendency of modern students, who confound dynamical activities with chemism itself, thus losing sight of the essential nature of the chemical process. As examples of this confusion he brings forward utterances of Clifford, Faraday, and Helmholtz. Faraday expressed his "conviction that the forces termed chemical affinity and electricity are one and the same." Helmholtz is quoted as saying—"I think the facts leave no doubt that the very mightiest among the chemical forces are of electrical origin, ... but I do not suppose that other molecular forces are excluded, working directly from atom to atom."

The atomic hypothesis is examined at some length in the eighth chapter. Dr. Hunt refers to Whewell's "History of the Inductive Sciences" (vol. i., Book vi., chap. 5). This writer declares that "the atomic doctrines, when they are tried upon the general range of chemical observation, prove incapable of even expressing, without self-contradiction, the laws of phenomena." Chemical facts not only do not prove the atomic theory as a physical truth, but they are not, according to any modification yet devised by the theory, reconcilable with the scheme." Further:—"When we would assert this theory, not as a convenient hypothesis for the expression or calculation of the laws of nature, but as a philosophical truth respecting the constitution of the universe, we find ourselves checked by difficulties of reasoning which we cannot overcome, as well as by conflicting phenomena which we cannot reconcile.

Dr. Hunt himself says, quoting—as he does largely in the present treatise—one of his own earlier works, if "the volumes of the uniting species are always merged in that of the new one, . . . the atomic theory, as applied by Dalton, which makes combination consist in juxtaposition, is untenable." It is, further, unnecessary for explaining the law of definite proportions. "If the law of volumes is universal, and if the production of liquids and solids by the condensation of vapours is a process of chemical union or integration, giving rise to polymeres, the equivalent weights of which are as much more elevated as their densities are greater than those of the vapours which combine to form them, the application of the hypothesis of atoms and molecules to explain the law of definite proportions and the chemical process is not only unnecessary but misleading." For a further development of this argument the reader may turn to a paper on "The Law of Volumes in Chemistry," given in the Chemical News (vol. liv., p. 206).

The transference of the atomic hypothesis from the theory of dynamics to the theory of chemistry, the author considers as springing from that confusion between dynamical and chemical actions to which he has already referred. Elasticity, the movements of gases and liquids, the phenomena of temperature, electricity, and radiant energy, seem to most physicists most intelligible if we assume that the species which is the seat of the phenomena has a structure not continuous but made up of discrete molecules or atoms of a definite and constant size, which in liquids and solids varies for each species. But, however this may be, Dr. Hunt argues that its acceptance or rejection has no direct bearing on chemism, which considers the species not as such, but merely with reference to the species from which it has been derived, or into which it may pass by processes of integration or disintegration.

On a former occasion he raises the question—"Are we not going beyond the limits of a sound philosophy when we endeavour by hypotheses of hard particles with void spaces, of atoms and molecules with bonds and links, to explain chemical affinities, and when we give a concrete form to our mechanical conceptions of the great laws of definite and multiple proportions to which space is subordinated? It must not be inferred, as might be easily done, that Dr. T. S. Hunt repudiates the use of rational and structural formulæ. If like Gerhardt and many others who have used such formulæ most successfully we remember that they are not intended to represent the actual position of atoms or the shape of molecules, but to make evident, in the simplest and most direct manner, the relations which connect bodies with one another, in their transformations they have, the author considers, "an important place in chemical teaching."

The salient points of Dr. Hunt's views are the rejection—or rather the non-acceptance—of the atomic theory; the representation of chemical union as not juxtaposition but identification; the distinction between chemical and dynamical action, and the relegation to the latter sphere of the phenomena of radiant energy, temperature, and electricity manifested in chemical changes. Liquid and solid species may be represented as polymers of some primary species. The generation of species dissimilar to the parents, by heterogeneous change, such as the union of hydrogen and carbon to form acetylene, he terms metagenesis. On the other hand, the generation of species like the parents in percentage composition, by homogeneous change, he calls metamorphosis. Steam, he considers, passes by polymerisation into the two distinct species, water and ice.

We will, however, make no further extracts, hoping that some of our readers will make themselves acquainted with this volume and find in it suggestions for research.

Chemistry for Beginners: adapted for the Elementary Stage of the Science and Art Departments' Examinations in Inorganic Chemistry. By R. L. Taylor, F.C.S., F.I.C., Teacher of Chemistry and Physics in the Central Higher Grade Board-School, Manchester. London: Sampson Low, Marston, Searle, and Rivington.

The shower of elementary treatises on chemistry which has prevailed for some years shows signs of abating, and will, we hope, cease until some capital discovery renders it necessary to revise the foundations of the Science. Like many—in our opinion, at least, too many—of its predecessors, this book is distinctly and avowedly examinational in its aims. It teaches such portions of chemistry and in such a manner as are required to enable the student to "pass" a certain examination. If we grant that this is the legitimate object in science-teaching—and in England it is almost forced alike upon teacher and pupil—we must admit that Mr. Taylor has accomplished his task in a very creditable manner.

At the end of the book we find the usual array of questions, though we are not informed whether they have been actually asked by the "Department" on former occasions.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 21, May 23, 1887.

General Law of the Vapour-Tension of Solvents.—F. M. Raoult.—One mol. of a fixed non-saline substance, whilst dissolving in 100 mol. of any volatile liquid, reduces the vapour-tension of such liquid by an almost constant fraction of its value, bordering upon 0·0105.

On Double Copper and Ammonium Iodides.—André Saglier.—The author has obtained a series of these compounds by causing copper hydroxide to react upon a

solution of ammonium iodide, with or without an excess of iodine.

Action of Heat upon Clays.—H. Le Chatelier.—The author remarks that hydrated aluminium silicates, in spite of their common occurrence and their important industrial uses, are little known as regards their chemical constitution. They form, generally, mixtures so complex, that analysis alone furnishes no precise data as to their nature. He considers that by studying the temperature of dehydration of these bodies it may be possible to identify a small number of chemical species, and to distinguish the presence of each of them in different mixtures. If a small quantity of clay is rapidly heated, there takes place, at the moment of dehydration, a retardation in the rise of temperature, and this point may be utilised for establishing a distinction between the various hydrated aluminium silicates. In some cases there occur, also, sudden accelerations, indicating reactions attended by a liberation of heat. The clays examined may be referred to five very distinct types.

On Erythrene Bromides.—E. Grimaux and Ch. Cloëz.—An account of the tetrabromide and the dibromide.

On Cyanacetophenone.—Alb. Haller.—This compound is obtained in the form of white needles, soluble in boiling water, alcohol, and ether, and very sparingly soluble in cold water and petroleum ether. Its melting-point (corrected) is 80·5°. The constitution of this ketone, which comprises a methylene group between two electronegative groups, and its reaction with vegetable colours point to an acid function less decided than that of cyanomalonic and acetylcyanacetic ethers.

Aniline Sebate and Diphenyl-sebacamide.—Gustave Gehring.—If two mols. aniline are allowed to react upon one mol. sebacic acid dissolved in alcohol, the aniline behaves like an ammonia, combining entirely with the acid without elimination of water. By evaporation in a vacuum, aniline sebate is obtained in transparent rhomboidal laminæ, colourless, and of a silvery lustre. It melts at 134°, and sublimes unchanged. Diphenyl-sebamide is obtained by heating in a flask, fitted with a refrigerating tube, equal weights of sebacic acid and aniline. The mixture melts at 110°, and boils at 180°. It is heated for sixteen hours, the temperature being raised at the end to 215°. The product is pulverised and recrystallised several times from boiling alcohol. The compound is neutral to reagents, forms small colourless, nacreous, rhombic scales, tasteless and inodorous. It melts at 198°, and sublimes, unchanged, at 360°.

Journal de Pharmacie et de Chimie.
Series v., Vol. xv., No 7, April 1, 1887.

Incompatibility of Nitrates and Superphosphates.—A. Andouard.—Already noticed under *Comptes Rendus*.

Assay of Quinine Sulphate by Means of Neutral Potassium Chromate.—J. E. de Vrij.—The reagent is a solution of 5 grms. neutral potassium chromate, very pure, in 100 c.c. distilled water, so that each c.c. contains 5 centigrms. of the salt. Two grms. of quinine sulphate are dissolved in 80 c.c. of boiling water, and 10 c.c. of the chromate solution are added. After the mixture has been kept for two hours at a temperature not exceeding 15°, stirring from time to time with a rod, it is thrown upon a filter. The crystalline quinine chromate remains upon the filter, whilst the filtrate contains merely a trace of dissolved quinine sulphate, 0·0378 part in 100 parts of the liquid if the sulphate is pure. In this case the liquid is not rendered turbid by the addition of a few drops of caustic soda. It remains clear after having been rendered alkaline, boiled, and allowed to cool again. If the sulphate contains cinchonidine, or others of the cinchona alkaloids, these bases are separated out under the same conditions. If the sulphate in question contains only one per cent cinchonidine sulphate, the filtrate rendered alkaline with soda remains limpid, even if heated to boiling. After cooling there is deposited at the bottom of the vessel a precipitate which is slight, but visible to the naked eye. If the quantity of foreign bases exceeds one per cent, the filtrate becomes turbid immediately after the addition of caustic soda, or at least after boiling.

Reactions of Kairine, Antipyrine, and Antifebrine.—C. A. Kohn.—In a dilute aqueous solution of kairine, a drop of ferric chloride gives, immediately, a violet colour, which quickly changes to a brown. An excess of ferric chloride in a strong solution of kairine gives a black-brown precipitate. Potassium dichromate gives, in a neutral solution of kairine an intense colouration, and a violet precipitate is shortly deposited. Antipyrine gives a red colour with ferric chloride, even in very dilute solutions; with nitrous acid a greenish blue colour is produced. Antifebrine gives no reactions with the above-named reagents.

Assay of Potassium Iodide.—M. Nicot.—The author prepares an acidified solution of sodium iodate, containing containing 4·78 grms. iodate, 15 grms. sulphuric acid, and distilled water enough to make up 1000 c.c. Fifty c.c. of this normal solution precipitate all the iodine contained in 100 c.c. of a pure 1 per cent solution of potassium iodide. One grm. of the sample is dissolved in 106 c.c. of distilled water, and the normal sodium iodate solution is added drop by drop from a graduated burette until a drop no lodger produces any colouration in the solution of iodide.

Determination of Morphine.—M. Dieterich.—The opium is treated with ten times its weight of water; to 50 grms. of the liquid extract are added 2 c.c. of normal ammonia (170 of caustic ammonia per litre) so as exactly to neutralise the liquid. The precipitate of narcotine is received upon a filter, and to 44·2 grms. of the liquid (=4 grms. of the opium) are added 10 grms. of ether and 4 c.c. of normal ammonia. The mixture is then set aside, stirring gently from time to time. After six hours the stratum of ether is drawn off, the mixture is again treated with 10 grms. of ether, the crystals of morphine are received upon a filter of 8 c.m. in diameter; they are twice washed with 5 c.c. of water, saturated with ether, dried at 100°, and weighed. All violent agitation of the extracting mixture and the ether must be avoided.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 6, March 20, 1887.

On Zinc Ferrite. Artificial Production of Franklinite.—Al. Gorgen.—The author has succeeded in obtaining a zinc ferrite identical in composition with the natural product.

Dissociation of Copper Sulphate.—Reply to an Observation by W. Müller Erzbach.—H. Lescœur.—The author contends that the value of the dissociation-tensions cannot be deduced from Müller-Erzbach's determinations.

Influence of Pressure and Temperature in the Action of Potassium Chloride upon Crude Carbonated Methylamine.—J. A. Müller.—For the complete transformation of potassium chloride into bicarbonate, making use of 2·14 mols. of crude methylamine carbonate for a double mol. of potassium chloride, and employing carbonic acid diluted to 25 per cent, we may either effect the carbonation at the ordinary pressure, and at a temperature bordering upon 0°, or at the ordinary temperature and a pressure of about three atmospheres.

Bulletin de l'Association of the Pupils of M. Fremy.
January, 1887.

Artificial Production of the Ruby.—M. Fremy.—This paper has already appeared in the *Compes Rendus*.

Action of Fluorides upon Alumina.— MM. Fremy and Verneuil.—Already noticed.

Report on the Researches of M. Colson.—M. Fremy.—The compound obtained by Wœhler on heating silicon in a lined crucible and considered by him as a silicon, is found to be a ternary compound, represented by the formula Si_2C_2N. In this body the carbon does not exist in a state of mixture, but of true combination, being, however, masked to such an extent that it does not burn if heated to redness in a current of oxygen. The same compound may be obtained by passing cyanogen over silicon at a red heat. M. Colson concluded that if this compound is formed by the union of nitrogen with the radicle Si_2C_2, this same silicon must be capable of uniting with other simple bodies, and he has, in fact, combined it with oxygen and with sulphur, obtaining the compounds Si_2C_2O, $SiCO_3$, and Si_4C_4S.

Causes Determining the Phosphorescence of Calcium Sulphide.—A. Verneuil.—Already noticed in the *Comptes Rendus*.

Practical Analysis of Coal-Gas.— M. Chevalet.—The author gives methods for the determination of hydrogen sulphide, carbon dioxide, oxygen, and carbon monoxide.

Alloy-resisting Acids.—M. Rettz has invented an alloy which offers great resistance to the action of acids and alkalies. It has the following composition :—

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Chemical Examination of Commercial Glycerin.—MM. Sulman and Berry determine the ash, the chlorides (volumetrically), the alkalinity, using litmus as indicator. The glycerins from stearine works contain from 0·5 to 2 per cent of alkalies, and the foreign organic matters.

Revue Universelle des Mines, de la Metallurgie, &c., Vol. xxi., No. 1, January and February, 1887.

Aluminium and its Alloys.—R. Van Langhenove.—The author describes the principal alloys of aluminium which he recommends for cannon and for the barrels of revolvers, as being cheaper than steel, lighter, and more resisting (7000 kilos. per square centimetre as against 4900 kilos.); aluminium silver, composed of aluminium, copper, and nickel; aluminium brass (5·8 Al, 26·8 Zn, and 67·4 Cu), and aluminium iron, containing 2 per cent of the former metal.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Regeneration of Nitric Acid.—An apparatus for the continuous regeneration of nitric acid from the lower oxides of nitrogen on a large scale can be obtained from Mr. Ludwig Rohrmann, Krauschwitz near Muskau, Germany (Lunge and Rohrmann's Patent).—G. L.

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THE CHEMICAL NEWS.

VOL. LV. No. 1440.

HER MAJESTY'S JUBILEE.—A SCIENTIFIC RETROSPECT.

III.

THE progress of the chemical arts and industries has been no less striking than that of chemical theory and of analysis. Indeed it has attracted the notice of the outside public to a much greater extent.

The first event which we have here to notice is the removal of the last of the excise-burdens upon the chemical arts. Everyone must know that in the early part of this century the manufactures of printed tissues, of leather, glass, paper, starch, and soap, were subject to taxes, and that, to ensure the due collection of these imposts, the works were placed under constant Excise supervision, and were subject to regulations which rendered improvement nearly impossible. Though certain of these duties had been repealed before the accession of Her Majesty, yet the excise on glass was only removed in 1845, and that on soap in 1853.

We cannot here enlarge on a system which seemed to have for its object the repression rather than the encouragement of native industry. But we must not forget that, even beyond the boundaries of the "excised" industries, the progress of the chemical arts was rendered difficult and perilous. The revenue official might and did claim the power to enter and inspect (or at least it was not prudent to refuse him) any newly established manufactory, in order to satisfy himself that no contraband business was being there carried on. It is even recorded that the inventor of "British gum" was actually thrown into prison, although the starch which served as his raw material had been bought from a licensed manufacturer after full payment of duty. He was released, it is said, only through the influence of the elder Peel, the father of the great statesman.

A leading feature of the Victorian epoch has been the utilisation of waste materials and by-products. Any industry having such foundations occupies a somewhat precarious position. Some novel improvement may put an end to the output of the by-product or the waste in question. Thus the waste carbon from the manufacture of prussiate of potash was found capable of certain utilisations. But the production of prussiate is now so very limited that the supply of this carbon is practically at an end, and those who required it must look elsewhere.

A very successful use of waste matter has been, and still is, the recovery of soap and grease from the waste waters of fullers and woollen manufacturers. This waste is still produced, and its supply is not likely to fall short. But there are a number of processes, all depending upon cheap hydrochloric acid, and all placed in jeopardy by the decline of the Leblanc alkali process.

The condensation of the volatile matter given off in coke-burning has attracted no little attention, and has been to a certain extent successful. But the present low prices of sulphate of ammonia and of tar-products render the profits of this recovery comparatively trifling. Still the most important of all the utilisations of waste matter have been the artificial colours manufactured from coal-tar.

Not a few kinds of waste materials still await a profitable utilisation, such as the (ordinary) slag from blast-furnaces, the tank waste from the Leblanc alkali process, and the washings from dye-works, which often contain much colouring-matter.

Among the most important practical inventions made during the half century must rank the Bessemer process and the Thomas and Gilchrist method for dephosphorising iron ores. Though both these capital improvements are of British origin they have proved of no especial benefit to British industry, since they have been at once adopted abroad. The basic slags from the Thomas and Gilchrist process are indeed, to a certain extent, displacing superphosphate. The manufacture of this latter substance, and of chemical manures in general, has had its rise, culmination, and, it must be added, its decline, within the Victorian era. Foreign competition renders the exportation of these products little remunerative, whilst the depression of agriculture during the last ten years has greatly curtailed the home market.

The alkali manufacture, though it originated in the last century, reached its climax between the years 1850 and 1870. Since that date it has been declining, especially in the Tyne district, and subsequently also in Lancashire. The causes are not far to seek: foreign competition, heavy import duties on British-made alkali and its by-products, and last, but not least, the rise of the ammonia-soda process. This invention, though of British origin, has been perfected in Belgium, and is, from a variety of reasons, more flourishing on the Continent than at home.

The manufacture of the coal-tar colours, though originating in England, flourishes much more in Germany, and even in Switzerland if we duly consider the unfavourable circumstances of the latter country, than with us. It is strange to look back now at the prophecies which were uttered when the manufacture of mauve, magenta, &c., first sprang up. Rarely have sanguine and admittedly plausible expectations been more signally falsified. If we make every allowance for the skill of the German chemists, who are trained not to pass examinations but to conduct researches, we must admit that a great part of the blame rests with our laws, which permit goods made in infringement of British patents to be sent to this country from abroad, provided that they are forwarded directly to the consumer and not sold here through agents, and which, on the other hand, allow aliens to hold and uphold a British patent without ever working it on British soil or granting licenses for such working.

The ultramarine manufacture, conducted so successfully in Germany and in France, does not seem to take root in this country. Ultramarine of excellent quality is indeed made in Britain, but on a limited scale, and we still derive the bulk of our supply from abroad.

Extracts of dye-woods, so extensively used by our dyers and printers, seem to be less extensively manufactured at home than formerly. French and American makes are preferred by many consumers.

One of the most important inventions of the epoch has been the production of paraffin wax and oil from the oil-shales of Scotland. This trade seems at present in a depressed state, due to the competition of American and Russian mineral oils.

The utilisation of sea-weed on the western coasts of Scotland and Ireland has its ebbs and flows. Iodine and bromine are now more abundantly obtained from other sources; but Mr. Stanford's discovery of algine has, we believe, a great future before it, though, like many other valuable novelties, it is slow in coming into general use.

In tissue-printing we seem still to keep ahead of the world as far as quantity is concerned, though the best designs are produced in Paris and the finest work is turned out in Alsace.

A serious reflection is that in spite of all the money we spend on technical and scientific education, and of all the self-laudatory speeches in which we indulge, the number of foreigners employed in the management of our industrial establishments seems not to decrease. One of two things must therefore be admitted: either we are naturally inferior to our Continental neighbours in aptitude for discovery and invention,—a conclusion which we shall be slow to accept in view of the men whom we have pro-

duced.—or our method of training is fundamentally wrong. Does the Science and Art Department ever seriously meditate on this alternative?

NOTE ON THE ELECTRO-DEPOSITION OF ALLOYS, AND ON THE ELECTROMOTIVE FORCES OF METALS IN CYANIDE SOLUTIONS.*

By SILVANUS P. THOMPSON, D.Sc., B.A.

It is known that the electro-deposition of such alloys as brass, bronze, and German silver is not practicable from mixed solutions of the sulphates or chlorides of the constituent metals, but can be accomplished by using cyanide solutions or neutral solutions containing cyanide of potassium in excess, thereby apparently departing from the law of Berzelius, that out of a solution of mixed metals the least electro-positive metal is deposited first.

To ascertain the cause of these facts the author has investigated—

(*a.*) The electromotive forces of a number of metals in aqueous solution of cyanide of potassium.

(*b.*) The dependence of these electromotive forces, in particular those of copper and zinc, upon the degree of concentration of the solution.

(*c.*) The variation of the electromotive forces of copper and zinc in a standard solution of cyanide of potassium at varying temperatures.

(*d.*) The electromotive forces of zinc and copper in a "brassing" solution consisting of the mixed cyanides of zinc and copper, having excess of cyanide of potassium present, and their variation at different temperatures.

It is found that the effect of higher concentration of the cyanide solutions is invariably to increase the electromotive force of copper more than it increases that of zinc.

In a cold dilute solution of cyanide of potassium the electromotive force of zinc against carbon is 1·158 volts, while that of copper against carbon is 0·948 volt, or zinc is 0·210 volt higher than copper. In a boiling saturated solution of cyanide of potassium, the electromotive force of zinc against carbon is 0·768 volt, and that of copper against carbon is 1·300 volt; or copper is 0·532 volt higher than zinc.

It is therefore possible to construct a voltaic battery containing one metal only, namely copper, and one electrolyte only, namely an aqueous solution of cyanide of potassium, kept hot at the anode and cold at the cathode of the cell.

In cyanide solutions containing about the following number of grms. of cyanide to the litre, the following were the electromotive forces observed with a carbon cathode:—

Solution containing per litre 99·4 grms.		Solution containing per litre 191·4 grms.		Solution containing per litre 1·18 grms.	
Metals at 18° C.					
Zinc ..	1·520	Copper ..	1·434	Zinc ..	1·13
Copper ..	1·425	Zinc ..	1·401	Brass ..	0·58
Brass ..	1·400	Brass ..	1·315	German silver	0·50
German silver	1·05	German silver	0·936	Lead ..	0·44
Gold ..	0·885	Gold ..	0·834	Copper ..	0·39
Silver ..	0·845	Silver ..	0·810	Silver ..	0·39
Lead ..	0·64	Lead ..	0·609	Gold ..	0·34
Iron ..	0·47	Iron ..	0·181	Steel ..	0·30
Steel ..	0·44	Steel ..	0·161	Iron ..	0·30
Platinum	0·27	Platinum	0·017	Platinum	0·14
Carbon ..	0	Carbon ..	0	Carbon ..	0

* A Paper read before the Royal Society, June 16, 1887.

Several of the metals exhibit maximum electromotive force at an intermediate concentration.

The following figures were obtained for zinc and copper in solutions of cyanide of varying strengths at 17° C.:—

Grms. per litre.	E.M.F. zinc.	E.M.F. copper.	Difference *Z*—C.
2·9	1·158	0·948	+0·210
5·9	1·167	0·967	+0·200
11·2	1·184	1·018	+0·166
23·8 .. .	1·221	1·058	+0·163
47·7	1·269	1·130	+0·139
95·5	1·303	1·220	+0·080
191·1	1·355	1·360	−0·005

In a mixed solution of cyanides of zinc and copper there is a neutral condition where the electromotive forces of zinc and copper are equal, and this neutral condition varies with the relative amounts of metal present, with the concentration of the solution, and with the temperature. The neutral temperature for a solution of given concentration is lowered by adding cyanide of potassium, and is raised by adding ammonia. The neutral point, however, is not well defined, the behaviour of copper being very uncertain; in general the electromotive force of clean copper in a cyanide solution rises, in some cases, as much as 0·06 volt, in a few seconds after immersion, but is rapidly though temporarily lowered on agitation.

Since the degree of concentration of the solution greatly affects the electromotive force of the metal, and since, in the act of deposition of a metal from its solution, the concentration of the liquid around the cathode is reduced, owing to slowness of diffusion, it follows that in electro-deposition the counter electromotive force at the cathode will vary with the rate at which metal is being deposited, and will, therefore, vary with the current-density employed. And since, moreover, the variations in electromotive force due to differences of concentration are greater for copper than for zinc, it follows that in the deposition of brass from a mixed solution of cyanides of a medium concentration, in which zinc is slightly more electro-positive than copper, there will be a certain density of current with which the metals will be deposited in nearly equal quantities, while for weaker current densities the less electro-positive metal will be deposited in excess, and for stronger current-densities the more electro-positive metal will be deposited in excess.

Hence, to variations in the concentration of the electrolyte near the cathode are due the departures, observed with all currents except weak ones, from the law that out of a solution of mixed metals the least electro-positive is deposited first.

DISPERSION EQUIVALENTS.*

By J. H. GLADSTONE, Ph.D., F.R.S.

Part I.

The idea of refraction equivalents has become familiar to those who work on the borderland of optics and chemistry, and the value of that property as a means of investigating the chemical structure of compounds is becoming more and more recognised. There is a similar property, perhaps equally valuable for the same object, which has attracted little attention hitherto; I allude to the equivalent of dispersion. During the last twelve months, however, I have collated old measurements of the length of the spectrum, whether made by myself or by others, and have added many new determinations, and I am now in a position to submit some of the results to the Society.

The history of the subject goes back to the first paper

* A Paper read before the Royal Society, June 16, 1887.

of Mr. Dale and myself upon the refraction of light,* in which we gave as one of the conclusions "the length of the spectrum varies as the temperature increases." In our second paper† we came to the conclusion that "there is no simple relation holding good for different liquids between the increase of volume and the decrease of dispersion by heat," contrary to what we found to be the case with refraction. We adopted $\mu_H - \mu_A$, *i.e.*, the difference between the refractive indices for the solar lines A and H as the measure of dispersion. This, divided by the density, gave the specific diversion. When, however, Landolt adopted the plan of calculating the "refraction equivalent," we applied the same method to what we termed the dispersion equivalent, that is, "the difference between $P\frac{\mu_A - 1}{d}$ and $P\frac{\mu_H - 1}{d}$, or more simply $P\frac{\mu_H - \mu_A}{d}$," where d equals the density of the substance and P its atomic weight.

In two communications made to the British Association,‡ we stated that the dispersion equivalent of any substance is little affected by the manner in which it is combined with other bodies, and we gave as the mean value of CH_2 0·35 in the vinic group, but higher figures in the benzene and pyridine groups; phosphorus equal to 2·9; chlorine 0·5; bromine 1·3; and iodine 2·6. In my subsequent paper in the *Philosophical Transactions*,§ in which the refraction equivalents of forty-six elements were worked out, I remarked, "the question of dispersion equivalents is also of interest; the data for the investigation of the matter are given in the Appendix." But there the matter rested. The paramount interest of the refraction equivalents in truth caused both the Continental observers and myself to neglect the question of dispersion; and with the exception of brief references to it in papers on Refraction,‖ nothing was published on the subject till last summer, when I applied the measurement of dispersion to the elucidation of the chemical structure of the essential oils;¶ and afterwards in a paper at Geneva** I ventured to give approximate values for fifteen elements.

Almost simultaneously with these appeared a paper by Brühl,†† in which he endeavoured to eliminate the influence of dispersion from the refraction equivalents of highly refractive bodies. In this he seems to establish the fact that, for such bodies at least, the theoretical formula of Lorenz $\frac{\mu^2 - 1}{(\mu^2 + 2)d}$, gives more uniform results than the empirical formula $\frac{\mu - 1}{d}$; but he draws as one of his conclusions, "the dispersion exercised by different bodies stands in no relation which is as yet clearly recognisable and measurable either with the refraction exerted by them, or with the chemical nature of the substances." In this and a following paper‡‡ he gives additional proof of the worthlessness of Cauchy's dispersion formula, or any of the suggested modifications of it, to eliminate the influence of dispersion.

It will be seen that Brühl's conclusion is inconsistent with the views I have recently expressed, and the determinations I had already published; but while I am free to confess that there are many difficulties in the investigation of dispersion which have not been felt in dealing with refraction, I hold that the following conclusions are fully warranted by the data:—

1st. That dispersion, like refraction, is primarily a question of the atomic constitution of the body; the general rule being that the dispersion equivalent of a compound is the sum of the dispersion equivalents of its constituents.

2nd. That the dispersion of a compound, like its refraction, is modified by profound differences of constitution; such as changes of atomicity.

3rd. That the dispersion frequently reveals differences of constitution at present unrecognised by chemists, and not expressed by our formulæ.

In this paper my object will be to point out the uniformity that does exist, leaving apparent exceptions for future consideration.

Before entering upon an attempt to determine the dispersion equivalents of the different elementary substances, it may be well to consider the difficulty which occurred at the threshold of the enquiry: and another which appears to have deterred Brühl from prosecuting his enquiries in the direction of dispersion.

The original experiments of Mr. Dale and myself led to the belief that the "specific dispersion, $\frac{\mu_H - \mu_A}{d}$, slightly diminishes with increase of temperature;" but more accurate experiments made on the same specimens of bisulphide of carbon, benzene, brombenzene, and mint terpene, at the temperature of the observing room in the height of summer and depth of winter, have made me less confident of this conclusion. The variations are certainly within the limits of experimental error. The observations of Wüllner both upon bisulphide of carbon and water, those of Baille and v. d. Willigen upon water, as well as those of Pisati and Paternó on benzene and cymene, show that there is little, if any, appreciable difference in the specific dispersion at different temperatures. The general tendency of the observations on the seventy substances which have been examined more or less carefully, appears to be that the small difference of specific refraction that exists at different temperatures is a little greater in the case of H than in that of A.

Brühl gives three cases of isomeric or quasi-isomeric bodies. He measures the specific dispersion by the B of Cauchy's formula divided by the density. He shows that cinnamic alcohol, $C_9H_{10}O$, and cinnamic aldehyd, C_9H_8O, both of which he conceives to contain four pair of doubly-linked carbon-atoms, have a widely different specific dispersion; that allyl paracresolate and anethol, $C_{12}H_{12}O$, having four pair of doubly-linked carbon-atoms, are also quite different in dispersion; and that, on the other hand, cymol and hexahydronaphthalin, both having the formula $C_{10}H_{14}$, but the first three pair, and the second two pair of doubly-linked carbon-atoms, have nearly the same dispersion. But if we reckon out the refraction equivalents for cinnamic aldehyd and for anethol from the numbers given in the same table, it will be seen that they are inconsistent with the supposition that these bodies have the chemical structure that he attributes to them; in fact the extremely high dispersion in each case only tells the same tale as the extremely high refraction. As to the two substances of the formula $C_{10}H_{14}$, it is open to question whether hexahydronaphthalin has only two pair of doubly-linked carbon-atoms; and the refraction equivalent calculated for each of the specimens throws some doubt upon their purity. Brühl also compares methyldiphenylamine with cinnamic aldehyd, but the presence of nitrogen in the first body, and the uncertainty as to the constitution of the second, render it unsafe to draw any conclusions from the comparison. That the specific dispersion of isomeric or polymeric bodies is practically the same, except where the constitution is very different (as in aniline and picoline), was shown in my paper in the *Philosophical Magazine* six years ago; and this must be set against the doubtful cases mentioned above.

The Elements.

There are but few of the elements of which the dispersive energy can be directly determined; but it so happens that

* "On the Influence of Temperature on the Refraction of Light," *Phil. Trans.*, 1858, p. 8.
† "On the Refraction, Dispersion, and Sensitiveness of Liquids." *Phil. Trans.*, 1863, p. 323.
‡ *Brit. Assoc. Rep.*, 1886. (*Trans. Sec.*, pp. 10 and 37.)
§ "On the Refraction Equivalents of the Elements." *Phil. Trans.*, 1869, p. 27.
‖ *Phil. Mag.*, vol. xi., 1881, p. 59; *Brit. Assoc. Rep.*, 1881 (*Trans. Sec.*, p. 591). *Chem. Soc. Journ.*, vol. xlvi., 1884, p. 258.
¶ *Chem. Soc. Journ.*, vol. l., 1886, p. 609.
** *Archives Sci. Phys. Nat.*, vol. xvi., 1886, p. 192.
†† *Liebig's Annalen*, vol. ccxxxv., 1886, p. 1.
‡‡ *Liebig's Annalen*, vol. ccxxxvi., 1886, p. 233.

two or three of these are among the most dispersive of bodies.

Phosphorus was determined by Mr. Dale and myself in a melted condition, and also by Damien both in that and the solid state. Our observation gives 3·1; those of Damien* work out at 2·9 and 2·8 respectively.

Sulphur.—An old observation of mine on this body liquefied, gave 0·90 for E – A; and recent observations from its solutions in bisulphide of carbon give 1·2 for F – A. These agree in indicating about 2·6 for H – A.

Selenium.—According to the observations of Sirks,† the refractive indices for A and D are respectively 2·653 and 2·98; taking the specific gravity at 4·5, the dispersion equivalent of this element would be the extraordinary amount of 5·67 for D – A alone.

Hydrogen.—Ketteler's‡ observations give a dispersion equivalent of 0·0152 for the difference between the green line of thallium and the red line of lithium.

Carbon.—Schrauf's§ observations upon diamond give 0·058 for the dispersion equivalent of the same range.

Iodine, in the state of vapour, or dissolved in bisulphide of carbon, gives a spectrum in which the order of the colours is abnormal.

Far more important results have been obtained from organic substances, by following a method similar to that which Landolt adopted in his determination of the refraction equivalents of carbon, hydrogen, and oxygen. The materials for such an enquiry are very abundant. They consist of the observations published by Mr. Dale and myself in 1863, and my more recent determinations published and unpublished; the very valuable lists of Landolt and Brühl, numerous observations by Kanonnikoff, Nasini, and others. The Continental observers have usually adopted the lines α, β, and γ of the hydrogen spectrum.

On comparing the refraction equivalents of organic liquids of the fatty acid series which differ from one another by CH_2, or multiples of it, my best determinations lie between 0·33 and 0·36, averaging about 0·35 for each CH_2. On treating in a similar manner fifteen series of such bodies in Brühl's tables, some of which contain many terms, the dispersion equivalent for $\gamma - \alpha$ works out very uniformly at an average of 0·215. This answers to 0·342 for H – A. Armstrong's cymhydrene, which is a saturated substance of the formula $C_{10}H_{20}$, has a dispersion equivalent of 3·44, giving therefore 0·344 for each CH_2. Kanonnikoff's determinations of tetraterpene and naphthene, also $C_{10}H_{20}$, give similar numbers. It may therefore be assumed that the value of CH_2 in saturated organic compounds lies between 0·34 and 0·35, answering to the well known 7·6 as the refraction equivalent of the same combination. When, however, we examine unsaturated compounds in a similar manner, we find that the value rises to at least 0·40.

Hydrogen.—While the value of CH_2 may be fairly taken at 0·34, it is more difficult to say what portion of this is due to the carbon, and what to the hydrogen. I have endeavoured to determine it, by deducting n times CH_2 from the paraffins C_nH_{2n+2}; by comparing the monatomic, diatomic, and triatomic alcohols, and by other similar means. The results are somewhat irregular, as might indeed be expected from the smallest of the residual figure, but give a mean of 0·04 per each hydrogen.

Carbon.—If the H_2 in CH_2 be taken at 0·08, it follows that the carbon will have a dispersion equivalent of about 0·26. This answers to the refraction equivalent of 5·0.

It is well known, especially from the researches of Brühl, that in unsaturated organic compounds there is an increase of refraction, for the line A, of about 2·2 for each pair of doubly-linked carbon-atoms. Assuming this to be due to a different value for carbon, we obtain a refraction equivalent of 5·0+1·1, *i.e.*, 6·1. In all such cases there is a great increase of dispersion; this increase, however, is not always the same. In the allyl compounds, whether determined by Brühl, Kanonnikoff, or myself, it is uniformly very close to 0·5. In the olefines it is the same. In the whole of the aromatic series it is at least 0·8. Coincident therefore with the higher refraction equivalent for carbon, we have two dispersion equivalents of about 0·26+0·25, and 0·26+0·40, *i.e.*, 0·51 and 0·66.

It must remain for future consideration whether there may not be an intermediate refraction equivalent, corresponding to the dispersion equivalent of 0·51.

On the appearance of Brühl's papers in 1880, I ventured to suggest that there was a still higher refraction equivalent for carbon, in those cases in which it "has all four of its units of atomicity satisfied by other carbon-atoms, each of which has the higher value of 6·0 or 6·1," as in naphthalene or pyrene. This view has been, and is, the subject of controversy, but on turning to the dispersion equivalents of these bodies, they are found to be always enormously high, far higher than can be accounted for by the figures with which we have hitherto been dealing.

Oxygen.—It has been established by Brühl, that in the case of aldehyds and ketones, oxygen has a refraction equivalent of 3·4. As these have the general formula $C_nH_{2n}O$, and the dispersion of CH_2 is known, it is very easy to determine the dispersion equivalent of the oxygen. Various determinations of these bodies give a fairly uniform result; viz., 0·18 for H – A.

In the case of the alcohols, the oxygen has a refraction equivalent of only 2·8. Comparing the dispersion equivalents of the alcohols of different atomicities in the published lists, the mean value for oxygen in this condition comes out at about 0·10. Nevertheless, in the organic acids and compound ethers, the value of the two oxygens together seems rarely if ever to exceed 0·24.

Chlorine.—Our lists also give us the means of determining the value of chlorine in organic substances of the fatty acid series. As reckoned from such substances as chloroform, chloral, ethylene, and ethylidine chloride, and bichloride of chlorethylene, the dispersion equivalent of this halogen appears to be 0·50, though in the simple chlorides of the compound radicles it appears to be a little less.

Bromine.—The dispersion equivalent of bromine varies in a similar way to that of chlorine. As deduced from bromoform and the dibromides of the olefines, it is 1·22; but in the bromide of ethyl it is lower.

Iodine.—The dispersion equivalent of iodine in di-iodide of methylene was found to be 3·65, and in iodoform in solution it seems to be about the same; while in the ordinary iodides of the compound radicles it is much less.

Nitrogen.—Nitrogen appears to have a lower value in nitriles, cyanides, and sulphocyanides than in organic bases: but the figures obtained so far, for each condition of nitrogen, are not accordant. The lower value, however, probably does not exceed 0·10. The values of NO_2 in the fatty acid series, as deduced from substitution products of the alcohols, glycerin, mannite, &c., are, however, fairly accordant, giving about 0·82.

Sulphur.—For the determination of sulphur, we have the excellent observations of Wiedemann,* and Nasini;† the first on sulphur substitution products of carbonic ethers, the second on many organic compounds. There exist also two or three observations of my own. It appears that the value of sulphur in mercaptans, sulphocyanides, and sulphides of ethyl, butyl, amyl, and allyl, is about 1·21; answering to the refraction equivalent of 14·0.

But in bisulphide of carbon, where the refraction equivalent of sulphur is 16·0, the dispersion equivalent is 2·61: and this is about the value which the element appears to have in the isosulphocyanides, while the element itself dissolved in bisulphide of carbon, gives 1·20 for the dispersion F – A, which is equivalent to fully 2·5.

* *Journal de Physique*, 1881.
† *Poggendorff, Annalen*, vol. cxliii., 1871, p. 429.
‡ *Poggendorff, Annalen*, vol. cxxiv., 1865, p. 390.
§ "Ueber das Dispersionsäquivalent von Diamant." *Wiedemann, Annalen*, vol. xxii., 1884, p. 424.

* *Journ. Prakt. Chem.*, vol. cxiv., 1873, p. 453.
† *Gazz. Chim. Ital.*, vol. xiii., p. 296.

These results are collected together in the following table. The dispersion equivalents here given, must, however, not be taken for anything more than approximate.

Substance.	Atomic Weight.	Refraction Equivalent A.	Dispersion Equivalent H−A.
Phosphorus	31	18·3	3·0
Sulphur, double bond	32	16·0	2·6
,, single bonds	,,	14·0	1·2
Hydrogen	1	1·3	0·04
Carbon	12	5·0	0·26
,, ...	,,	6·1 ?	0·51
,, ...	,,	6·1	0·66
Oxygen, double bond ..	16	3·4	0·18
,, single bonds ..	,,	2·8	0·10
Chlorine..	35·5	9·9	0·50
Bromine..	80	15·3	1·22
Iodine	127	24·5	3·65
Nitrogen	14	4·1	0·10
CH_2	14	7·6	0·34
NO_2	46	11·8	0·82

It will be seen by a glance at this table that the dispersion equivalents of the elementary substances are not in proportion to their atomic weights, or, in other words, that they have different specific dispersive energies. Thus the analogous elements, sulphur and oxygen, are strongly contrasted in this respect; their specific refractive energies being respectively 0·081 and 0·011. Again it will be evident that the proportion between the refraction and dispersion is not the same even in the case of analogous elements. Thus, taking the three halogens, the ratio between the refraction for A and the dispersion for H−A for chlorine is about 100 to 5, for bromine 100 to 8, and for iodine 100 to 15.

Metals in Salts.—In 1869, as already stated, I suggested that the same data from which the refraction equivalents of the metals had been determined would be available also for their dispersion equivalents. I have many observations in addition to the data then published; and Kanonnikoff has been over part of the same ground, measuring the α and β of the hydrogen spectrum. Unfortunately, however, the errors of observation bear so considerable a proportion to the whole amount observed, at any rate in dilute solutions, that we cannot look upon single determinations of the dispersion equivalent of a salt as of much value. Thus, even when great care has been taken in measurement, each index of refraction is liable to an error of $\pm$0·0001, and as the error in determining A and H may be in opposite directions, $\mu_H - \mu_A$ cannot be relied upon within $\pm$0·0002. Now among solutions of salts the specific dispersion rarely amounts to 0·02; the error of observation may therefore be more than 1 per cent, and if the salt should form only 5 per cent of the solution, the error might exceed 20 per cent. Such solutions, therefore, are practically valueless for this purpose. Yet it would be easy to publish a table of miscellaneous salts, the dispersion equivalents of which had been deduced from several fairly accordant observations on fairly strong solutions, or which have been corroborated from some independent source. It has appeared preferable, however, to confine attention at present to the series of potassium and sodium salts, which are far the most complete and the most instructive.

It is evident at a glance that the figures in the sodium columns are invariably lower than those in the potassium columns, and that the difference is fairly uniform. In regard to the refraction equivalent, it is about 3·33,† and in the dispersion equivalent it is about 0·09.

It follows, that if we can determine the value of potassium, that of sodium may be at once calculated: and presumably the same process may be extended to all other metals that form soluble salts.

But it is not so easy to determine the value of potassium. In regard to the refraction equivalent, my original determination was 8·1; but Kanonnikoff gives only 7·75, which led me, three years ago, to recalculate the observations, taking Brühl's values for oxygen, and to reduce my previous estimate to 7·85. This is determined mainly from the organic salts, and the nitrate and cyanide. I did not draw any conclusion from the haloid salts, as the chlorine, bromine, and iodine in them appear to have somewhat higher values than what they have in organic compounds.

How are we to determine the corresponding equivalents of dispersion? From the haloid salts it would seem to be about 0·8, but it seems likely that the disturbing influence, whatever it be, which increases the refraction of the haloid salts, should affect the dispersion. The formate and acetate, $KCHO_2$ and $KC_2H_3O_2$, promise more trustworthy results, as we can substract from their dispersion equivalents the numbers already determined for carbon, hydrogen, and oxygen. This will give respectively 0·53 and 0·44 for the dispersion equivalent of K.

If we view potassium hydrate, KHO, as water in which one hydrogen is replaced by potassium, water being 0·265, we obtain the value of 0·565 for K.

From the nitrite, KNO_2, by subtracting 0·82 for NO_2, we obtain 0·48 for K.

In like manner from the cyanide, KCN, by deducting 0·36 for cyanogen, we get 0·58 for K.

From the carbonate, K_2CO_3, by taking the probable value of the CO_3 at 0·60, we get 0·40 for each K.

From the oxalate, $K_2C_2O_4$, by deducting 1·00 we get 0·59 for each K.

These figures, varying from 0·40 to 0·59, are too uncertain, and too wide to give a good average. I doubt if such variations can be attributed wholly to experimental error; but, on the other hand, it is difficult to imagine that potassium should have more than one dispersion equivalent while in the same series of dissolved salts it has apparently one and the same refraction equivalent. I am more disposed to believe that the uncertainty lies in the value of radicles to which the metal is joined; but this will require a more extended research.

It is also an important enquiry:—To what extent does the modification of the dispersion equivalent affect the refraction equivalent for the line A? On this question, and others of a similar nature, I hope shortly to submit a further communication. I think it will be already

† Previously determined at 3·3.

	Refraction Equivalent.			Dispersion Equivalent.		
	Potassium.	Sodium.	Difference.	Potassium.	Sodium.	Difference.
Chloride	18·83	15·40	3·43	1·27	1·18	0· 9
Bromide	25·25	21·80	3·45	2·17	2·08	0·09
Iodide	35·78	32·52	3·26	4·42	4·33	0·09
Hydrate	12·60	9·26	3·34	0·79	0·72	0·07
Formate	20·01	16·60	3·41	1·07	0·96	0·11
Acetate	27·52	24·34	3·18	1·32	1·23	0·09
Carbonate	28·63	22·17	2(3·23)	1·40	1·34	2(0·03)
Oxalate	37·55	—	—	2·18		
Nitrite	18·99	15·65	3·34	1·30*	1·17	0 13
Cyanide	17·18	—	—	0·94		

* This is estimated from measurements of A, F, and G, and is somewhat open to doubt, as there seems to be something abnormal in the spectrum

sufficiently obvious that the specific dispersive energy of a compound body is a physical property analogous to, but distinct from, its specific refractive energy; and that it is capable in like manner of throwing light upon chemical structure.

ON KREATININS.*

I. On the Kreatinin of Urine, as distinguished from that obtained from Flesh-Kreatin.

II. On the Kreatinins derived from the Dehydration of Urinary Kreatin.

By G. STILLINGFLEET JOHNSON, M.R.C.S., F.C.S., F.I.C.

Part I.

This investigation was suggested by a careful study of the reducing action of normal human urine upon picric acid in presence of potash at the boiling temperature.

The picric acid method for the quantitative estimation of sugar in urine was introduced by Dr. George Johnson in 1883. Whilst assisting him in working out the details of the process, the author's attention was drawn to the small amount of reduction exerted by *all* specimens of normal human urine. The average picric reduction observed was equal to that which would be effected by a solution of glucose containing 0·6 grain to 1 fluid ounce.

The reduction of cupric oxide in boiling alkaline solution was always somewhat greater, averaging 0·7 grain per 1 fluid ounce. Although many physiological chemists express the opinion that normal human urine contains always a little sugar, to which this reducing action is to be attributed, the author's researches have led him to an opposite conclusion.

The reducing agent of normal urine differs from glucose in producing some reduction of picric acid in presence of potassium hydrate at the ordinary temperature (*vide* Dr. R. Kirk, *Lancet*, June 16, 1883).

The reducing agent of normal urine cannot be made to undergo the alcoholic fermentation in presence of yeast. Nevertheless Dr. Pavy (*Med. Chir. Soc. Trans.*, vol. lxiii., p. 222) attributes one-fourth of the reducing action of normal urine upon cupric oxide to uric acid, and the remaining three-fourths to "the small amount of sugar naturally present in urine."

Brücke is also of opinion that normal human urine contains a small quantity of sugar.

Uric acid and kreatinin together are credited by Prof. E. Salkowski (*Centralblatt fur die Medicinischen Wissenschaften*, March, 1886) with from one-sixth to one-fifth of the total reducing action of normal urine, the remainder being due to "other substances, and very probably to compounds of glycuronic acid (*Glycuron-säure-verbindungen*)."

The author found that about three-fourths of the total reducing action of normal urine is destroyed by prolonged boiling with potassium hydrate, the remaining one-fourth being due to the survival of the uric acid, thus confirming Dr. Pavy's observation that one-fourth of the normal reducing action is due to uric acid.

On attempting to isolate the normal reducing agents by precipitants, it was found that mercuric chloride gradually effected complete precipitation of the reducing agent when added in sufficient excess to the unconcentrated urine. Complete precipitation can be effected in forty-eight hours if one-twentieth of its volume of a cold saturated solution of sodic acetate be first added to the fresh urine, then one-fourth of its volume of a cold saturated solution of mercuric chloride. The precipitate, which forms immediately, should be separated by filtration, as it contains no reducing agent except uric acid, which is probably present in it as mercuric urate; but the filtrate from the first amorphous precipitate begins to deposit the mercury salt of the reducing base in about half an hour. This deposit appears granular and crystalline, but under the microscope is found to consist of minute spherical masses. The weight of the dry spherical precipitate is always greater than that of the amorphous one weighed in the same condition. The desiccation must be conducted over sulphuric acid at the ordinary temperature, since the compound is decomposed at 100° C. in presence of water.

The filtrate from this granular (spherical) mercury salt is devoid of reducing action upon cupric oxide and picric acid. The spherical mercury salt of the reducing base (for the basic nature of the normal reducing agent is strongly indicated by the above results) is easily soluble in hydrochloric acid, but insoluble in acetic acid. Moistened with solution of potassium hydrate, the compound gradually blackens from reduction of mercury at the ordinary temperature, and much compound ammonia is evolved. Suspended in cold water and treated with hydrogen sulphide, the compound is decomposed, mercuric sulphide remaining undissolved, whilst the solution becomes acid in reaction and exhibits reducing properties On evaporating this acid solution a crystalline salt is obtained, which is the hydrochloride of the reducing base. As the spherical mercury salt, obtained as above from urine, appeared to be always quite homogeneous and pure, with the exception of a little colouring-matter, the exact weight of the compound obtained from known volumes of urine was next ascertained.

The samples of urine examined were in all cases ascertained to be free from albumen and sugar before precipitation. The filtrates from the first or amorphous precipitate, produced by mercuric chloride and sodic acetate, were allowed to collect in a large glass vessel, in which the spherical compound gradually accumulated. After standing some days the total precipitate was collected, washed with cold water, dried in a vacuum over H_2SO_4, and weighed.

(I.) 34,640 c.c. of urine gave 198 grms. of Hg salt, equivalent to 5·7 grms. of Hg salt per litre of urine.

(II.) 40,625 c.c. of urine gave 293·13 grms. of Hg salt, equivalent to 7·19 grms. of Hg salt per litre of urine.

The mean specific gravity in Experiment I. was 1·020, and the mean reduction of picric acid was equivalent to 0·67 grain glucose per 1 fluid ounce.

The mean specific gravity in Experiment II. was 1·022, and the mean reduction of picric acid was equivalent to 0·86 grain of glucose per 1 fluid ounce.

In my own case I found that the mean quantity of mercury salt obtained from the urine of twenty-four hours agreed very nearly with the above results, the total urine of six days having been carefully collected and examined each twenty-four hours.

The following table shows the weight of dry mercury salt of urinary kreatinin and of dry "1st mercury precipitate,"—*i. e.*, is the precipitate which is formed immediately when $HgCl_2$ is added to the fresh urine.

Weight of the body at the time of experiment, 70·08 kilogrammes.

Date.	Vol. of Urine passed in 24 hours.	Weight of 1st Hg ppt. in grms.	Weight of 2nd Hg ppt. in grms.
Dec. 29—30 ..	1790 c.c.	5·355	9·076
,, 30—31 ..	1360 ,,	9·238	9·930
,, 31—Jan. 1	1575 ,,	7·300	8·758
Jan. 1—2 ..	1230 ,,	6·715	8·176
,, 2—3 ..	1700 ,,	4·985	8·932
,, 4—5 ..	1275 ,,	7·735	7·955

It will be seen from this table that the weight of the spherical mercury salt of the reducing kreatinin is always greater than that of the first or amorphous mercury precipitate, and that the weight of the former obtained from the total urine of twenty-four hours is much more constant than that of the latter.

* Abstract of a Paper read before the Royal Society, June 16, 1887.

From the above table the following averages are obtained :—

Average 1st Hg ppt. in 1000 c.c.	4·62 grms.	Max. 6·8 Min. 2·93
Average *spherical* Hg ppt. in 1000 c.c. ..	5·9 ,,	Max. 7·3 Min. 5·07
Average 1st Hg ppt. in 24 hours	6·888 ,,	Max. 9·238 Min. 4·985
Average 2nd Hg ppt. (spherical) in 24 hrs.	8·804 ,,	Max. 9·930 Min. 7·995.

Ratio of *kreatinin* excreted in twenty-four hours to body weight = 25 : 1,000,000.

The formula of the spherical mercury salt arrived at by analysis is $4(C_4H_7N_3O.HCl.HgO).3HgCl_2$.

It may here be observed that mercuric chloride has been recommended by Maly (*Ann. Chem. Pharm.*, vol. clix., p. 279) for preparing kreatinin from the urine of man or the horse. He does not mention the fractional precipitation by mercuric chloride, but recommends a preliminary concentration of the urine by heat, and precipitation by basic lead acetate before adding mercuric chloride. On repeating his process I found that even after the removal of the uric acid, &c., by basic lead acetate, the mercuric chloride still produced an immediate flocculent precipitate, followed by a granular one; and if the flocculent amorphous matter was not separated by filtration, the total mercury precipitate yielded a gummy mass after treatment with H_2S, which would not yield crystals until treated with alcohol, as Maly himself recommends. By my method, however, the hydrochloride of the reducing base is obtained in crystals after the first evaporation: these crystals contain chlorine in the proportion required by the formula $C_4H_7N_3O.HCl$.

The *platinum salt* of the reducing base is obtained in the form of anhydrous crystals, when an alcoholic solution of its hydrochloride is mixed with an alcoholic solution of platinic chloride. If these anhydrous crystals be dissolved in water, and the solution evaporated, or if the aqueous solution of the hydrochloride of the base be mixed with platinic chloride in aqueous solution and evaporated, fine orange-coloured prisms separate out, which have the formula $2(C_4H_7N_3O.HCl).PtCl_4.2H_2O$. Heated to 100° C. these crystals become anhydrous, yellow, and opaque.

The *free reducing base* is obtained from its hydrochloride by mixing the concentrated aqueous solution with excess of pure lead hydrate* *without heat*, and filtering; the alkaline filtrate by spontaneous evaporation deposits large square plates with bevelled edges, or long efflorescent prisms if great care is taken to avoid heating the solution of the hydrochloride. The aqueous solution of the free base is alkaline in reaction, intensely bitter to the taste, gives crystalline precipitates with zinc chloride, mercuric chloride, and picric acid, but none with silver nitrate, unless the solution be very concentrated.

The reducing base, which is undoubtedly the natural kreatinin of urine, when anhydrous, has the empirical formula $C_4H_7N_3O$, but the efflorescent kreatinin, obtained only when great care is taken to avoid heat, has the composition $C_4H_7N_3O.2H_2O$. After efflorescence this body has the same percentage composition as the anhydrous tabular kreatinin :—

One part by weight of the tabular kreatinin dissolves in 10·78 parts of water at 17° C.

One part of the tabular kreatinin dissolves in 362 parts of absolute alcohol at 17° C.

The efflorescent kreatinin (before efflorescence) dissolves in 10·6 parts of water at 14° C. The effloresced kreatinin requires 14 parts of water at 14° C. for solution.

* The lead hydrate employed for removing chlorine from the kreatinin hydrochloride must be free from *basic nitrate*, otherwise lead will be found in the solution of the free base. The lead hydrate which the author has found to give the best results is that obtained by precipitation of *lead acetate* by ammonia.

The natural kreatinin of urine reduces cupric oxide in proportion as 12 : 10 parts by weight of glucose.

The average weight of this base passed by a healthy man in twenty-four hours (as determined by weighing the spherical mercury salt precipitated from the urine as above) is from 1·7 to 2·1 grms., equivalent in reducing action upon cupric oxide to from 1·5 to 1·75 grms. of glucose (= 23 to 27 grains of glucose in 52·8 fluid ounces of urine).

Therefore cupric oxide will be reduced by the normal urinary kreatinin in quantities equivalent to the reduction effected by 0·43 to 0·51 grain of glucose per 1 fluid ounce. The conclusion is that the total reduction effected by normal urine is accounted for by the uric acid and kreatinin which it contains.

There is every reason to believe that the natural kreatinin of urine is the efflorescent kreatinin,—

$$C_4H_7N_3O.2H_2O,$$

which is now described for the first time; for this compound is obtained only when the greatest care is taken to employ no *heat* throughout the process of extraction.

The following results of the re-crystallisation of this compound from aqueous solutions, made at different temperatures, indicate that the water ($2H_2O$) in this efflorescent base is not in the condition of simple water of crystallisation.

After efflorescence, if the effloresced kreatinin be dissolved in water at the ordinary temperature, the solution yields efflorescent kreatinin again on evaporation *in vacuo* over H_2SO_4.

But if the effloresced kreatinin be dissolved in water at 100° C., in quantity sufficient to hold the base in solution on cooling to the ordinary temperature, tabular anhydrous kreatinin is obtained when this solution is evaporated *in vacuo* over H_2SO_4.

Again, if the tabular kreatinin be kept in aqueous solution at 60° C. for some time, *efflorescent kreatinin* results when the cooled solution is evaporated *in vacuo* over H_2SO_4.

Further details on this point are to be found in the original paper.

Part II.

The natural urinary kreatinin yields a kreatin when its dilute aqueous solution is subjected to prolonged ebullition; and this kreatin, when treated by Liebig's process, is converted into kreatinin hydrochloride.

This artificial kreatinin hydrochloride differs from the hydrochloride of the natural kreatinin of urine, in that it crystallises from cold aqueous solution in efflorescent crystals, whereas the hydrochloride of the natural base is always anhydrous.

Efflorescent and tabular kreatinins may be obtained from this hydrochloride, resembling in crystalline form and percentage composition those derived from the natural hydrochloride, but exhibiting some important differences. Thus the platinum salt of the artificial tabular kreatinin requires nearly twice as much water to dissolve it as that of the natural base at the same temperature.

Both the natural and artificial kreatinins form well-crystallised gold salts. The gold salt of the natural kreatinin is unchanged by ether, but that of the artificial base is decomposed thereby, the kreatinin hydrochloride separating out, and the auric chloride passing into solution.

Finally, the artificial kreatinins are less powerful reducing agents than the natural base.

Four mols. of the natural kreatinins are equivalent to two mols. of glucose.

Five mols. of the artificial kreatinins are equivalent to two mols. of glucose in reducing action.

Therefore artificial kreatinins must not be compared with the natural base as to their reducing action.

Prof. W. N. Hartley has observed a marked difference in the absorption spectra of the natural kreatinin of urine, and of an artificial kreatinin obtained by the author from flesh kreatin.

Tabular Synopsis of Comparison between various Kreatinins.

	1. Efflorescent kreatinin of urine, $C_4H_7N_3O.2H_2O$.	2. Tabular kreatinin of urine, $C_4H_7N_3O$.	3. Efflorescent kreatinin from urinary kreatin, $C_4H_7N_3O.2H_2O$.	4. Tabular kreatinin α from urinary kreatin, $C_4H_7N_3O$.	5. "Kreatinin" (Liebig).
Solubility of base in water	1 in 10·6 parts at 14° C.	1 in 10·78 parts at 17° C.	—	1 in 10·68 parts at 16·5° C.	1 in 11·5 parts at 16° C.
Solubility of base in alcohol	—	1 in 362 parts at 17° C.	—	1 in 324 parts at 18·5° C.	1 in 102 parts at 16° C.
Platinum salt	Indefinite or decomposed by alcohol.	$2(C_4H_7N_3O.HCl).PtCl_4.2H_2O$.	Indefinite, or decomposed by alcohol.	$2(C_4H_7N_3O.HCl).PtCl_4.2H_2O$.	$2(C_4H_7N_3O.HCl).PtCl_4$.
Solubility of platinum salt in water	—	1 in 14·1 parts at 15° C.	—	1 in 24·4 parts at 15° C.	—
Gold salt	$C_4H_7N_3O.HCl.AuCl_3$. Unchanged by ether.	$C_4H_7N_3O.HCl.AuCl_3$. Unchanged by ether.	$C_4H_7N_3O.HCl.AuCl_3$. Decomposed by ether.	$C_4H_7N_3O.HCl.AuCl_3$. Decomposed by ether.	—
Reduction of cupric oxide by base compared with that of glucose	4 molecules $C_4H_7N_3O$ = 2 molecules glucose (after efflorescence.)	4 molecules = 2 molecules glucose.	5 molecules $C_4H_7N_3O$ = 2 molecules of glucose (after efflorescence).	5 molecules = 2 molecules glucose.	—

Crystallographic measurements of the tabular and efflorescent kreatinins, made by Messrs. L. Fletcher and H. A. Miers, are to be found in the paper, together with full analytical details.

THE NITRATION OF CELLULOSE.

By F. NETTLEFOLD, F.C.S.

NOTWITHSTANDING that it is now more than forty years since gun-cotton was first made on a manufacturing scale, it still holds its place against the more recent inventions. Lower nitrated celluloses are made on a large scale for powder, and also for pyroxylin. A few remarks on the influence of the nature of the fibre on the condition of nitration may perhaps be not uninteresting to the readers of the CHEMICAL NEWS.

It will be readily understood that the thin wall tubes of cotton fibres are readily penetrated by the mixed acids, and consequently the highest state of nitration results. In the case of ligneous tissue the cells have been thickened by matter from the sap, and almost blocked up. This thick wall is not so readily penetrated, and so only lower nitro-bodies can be obtained.

Thus with clean cotton, using a mixture of 33·3 per cent nitric acid, 1·506 sp. gr. of 94 per cent HNO_3, and 66·7 per cent H_2SO_4, sp. gr. 1·840, a near approach to trinitro-cellulose is attained,—a product with a solubility of 7 to 9 per cent, having a proportion of nitrogen 13·94 to 13·86 per cent, against a theoretical proportion of 14·14 per cent N in pure trinitro-cellulose, when 0·85 per cent is deducted for ash.

Since so large a quantity of wood pulp is used in the manufacture of powder, such as the Schultze, it may be interesting to consider the few following experiments to show what definite result arises in nitrating these different bodies, though often described—in the case of wood — as consisting of vasculose, para-cellulose, and fibrose.

Beech wood and fir wood are not easily nitrated, on account of the unstable compounds they form. In the case of a fine sample of white pine flour, named O in commerce, a dark ochre-coloured product was obtained with—

41·6 per cent soluble in a mixture of 2 parts absolute ether, 1 part alcohol.
58·4 per cent insoluble in ditto.

The total nitrogen in this was 11·2 per cent.

Taking the soluble portion as being dinitro-cellulose, the insoluble remainder would have a proportion of 11·3 per cent nitrogen, or a rather higher state of nitration.

A sample of wood pulp gave also 11·2 per cent N.

The resinous matter was extracted by boiling in caustic soda, and the washed residual fibre was nitrated, yielding 11·57 per cent N. This proportion of nitrogen would indicate that the product lay between dinitro-cellulose and the formula given by some authors as—

$$C_{24}H_{37}(NO_2)_9O_{20},$$

with 11·9 per cent. It might be conceived at first sight that the insoluble portion consisted of a mixture of trinitro-cellulose and unnitrated fibre, but, as a matter of fact, woody tissue is not readily brought to this high state of nitration.

The existence of these more complicated nitro-bodies, with four times the formula $C_6H_{10}O_5$, is further seen in the following instance :—

Cotton was nitrated in weak acid, yielding a product—

33·0 soluble in the mixture of ether and alcohol.
63·5 „ acetic ether.
3·5 insoluble.

Taking the 33 per cent as containing 11·1 per cent N, as dinitro-cellulose, the 63·5 per cent would have 10·1 per cent; analysis gave 10 per cent. The formula—

$$C_{24}H_{33}(NO_2)_7O_{20}$$

has 10·17 for theory. With—

25 per cent nitric acid, 75 „ H_2SO_4 } 10·47 per cent N.
20 per cent nitric acid, 80 „ H_2SO_4 } 8·23 per cent N.

The latter product might be near to the $C_{24}H_{35}(NO_2)_5O_{20}$, with 8·02 per cent N.

With the mixture of strong acids—

$$33{\cdot}3\ HNO_3,$$
$$66{\cdot}7\ H_2SO_4,$$

and various quantities of water, ranging from 10 to 15 per cent, to form collodions, products ranging from 10 to 11·1 per cent nitrogen are obtained: these are all soluble in acetic ether, and are probably homogeneous chemical products.

In the Schultze powder the nitrated wood fibre has 10·44 per cent N lying between—

$$C_{24}H_{33}(NO_2)_7O_{20} \text{ and } C_{24}H_{32}(NO_2)_8O_{20},$$

or between 11·1 and 10·17 per cent. But in order to obtain this in the case of cotton, a dilute acid is required, whereas in the case of wood fibre the strongest has to be taken.

NOTICES OF BOOKS.

Colonial and Indian Exhibition.—Reports on the Colonial Sections. Edited by H. Trueman Wood. London: Wm. Clowes and Sons, Limited. 1887.

It was originally intended to confine the Reports of this Exhibition to the consideration of raw products only, or such manufactures that might be of importance to trade between England and her Colonies. A few exceptions have, however, been made in the case of some exhibits which appeared to be of special interest.

The first report is on Mining Industries, by C. Le Neve Foster, and is, owing to the vast mineral resources of our possessions, of very great importance. The collection of metallic ores, coal, and other minerals, was an extensive one, and attracted a good deal of attention from visitors to the Exhibition. In these pages we find the exhibits of each colony thoroughly described, giving even a better idea of their diversity and value than could be obtained by a mere inspection.

The supply of grain is a question which is of universal interest. Wheat, which has been called "the king of grains," is the principal food-stuff of our race. Its cultivation of late years has increased so enormously abroad that it no longer pays the farmer to grow it at home. Canada, our oldest colony, is the first examined in this report, but it does not appear that the export has yet reached a very large total: much is, however, expected in the course of a few years from Manitoba and the North-West Territories.

Victoria has been making rapid strides during the past fifteen years, during which period the land under cultivation has been trebled in extent. Since 1877 Victoria has exported wheat regularly, and in some years largely, but is beaten by South Australia, whence wheat has been exported since 1850, and last year to the amount of 1½ million quarters.

Passing over tea, coffee, sugar, &c., we come to wines, spirits, and such like. New South Wales is said to possess "districts of sufficient area, and combining the necessary conditions of soil, climate, and aspect, to produce wine enough to supply the whole of the world." The vine is not indigenous to Australia, but being imported in 1820 it flourished and multiplied, and the wine-making industry is now assuming considerable importance.

The Cape of Good Hope is far earlier in viticulture than the Australian colonies, the cultivation of vines having commenced there about the year 1653. Between 1880 and 1885 the number of vines increased from 60 to 70 millions.

The report on Drugs, and Chemical and Pharmaceutical Products, is more of a catalogue of the articles exhibited; but interesting notes are found on *Cinchona Bark* and other exhibits.

Wool, silk, and timber are three raw materials of very great importance. The silk from South Australia is very favourably spoken of as being superior to that from China and equal to Japanese or Italian. That from the other colonies is also praised, and the continued search for indigenous species of silk-producers is strongly urged.

The whole volume from cover to cover is of extreme interest, and it is a difficult task to say which colony is the most valuable; all have their special advantages, and all are progressing.

On Forecasting the Weather. By B. G. Jenkins. Brussels: F. Hayez. 1877.

Forecasting the weather is a question which interests everybody, no matter what his occupation may be; and it may be safely asserted that, no matter what weather we have, there are sure to be thousands of persons who will grumble and find fault with it.

Of recent years the science of forecasting has been vastly improved, the improvement being principally due to the rapid communication between one station and another by means of the electric telegraph, but, even with this at the disposal of our meteorological department, it is not very uncommon for the results to be hopelessly different from the weather expected.

The boldest idea in this direction is undoubtedly that now put forward by Mr. Jenkins. He professes to forecast the weather of any year simply by knowing what it was sixty-two years ago. He says:—"By a process which it is not necessary for me to enter into now, I have found that the barometric and thermometric readings for London, for this year 1887, will be practically the same as those which have been recorded for the year 1825." In proof of this statement he gives charts of the pressure and temperature for the same months in these two years. With regard to the temperatures we admit that there is a great resemblance, but one year is so like another that we cannot admit the proof, while the curves of barometric pressure seem to us to be very far from coinciding. The cause of this alleged similarity is, Mr. Jenkins tells us, the position of the moon. But on examining the charts carefully we cannot come to any other conclusion than that the moon has little or nothing to do with it. How is it possible that the moon can affect the temperature of a day in June, or the rainfall of the month of January? these being cases in which a similarity exists. The moon might possibly have some influence on the height of the barometer, in somewhat the same way as she produces tides, but it is precisely in this case that a want of agreement occurs.

One more point we cannot pass over in silence. Mr. Jenkins attributes some of the differences between two years which *ought* to agree "to inequalities in the moon's daily motion."

Technology Quarterly. Vol. i., No. 1. Massachusetts Institute of Technology, Boston.

A large amount of work done by the advanced students of the Institute having no regular channel for publication, it was thought that this new Journal would be an excellent medium for recording the original researches and investigations carried on by them. The contents of this, the first number, are of a most varied character, comprising chemistry, engineering, physics, electricity, biology, &c.

The paper describing a method for calibrating a thermometer at many points is of considerable interest. Most methods which have been used are only applicable for obtaining corrections at considerable intervals; but the method here described has been devised so as to obtain corrections for very short intervals, and to avoid the accumulation of errors which previously made the results so unsatisfactory.

A paper on the constitution of benzol will be read with

interest by all chemists, as the subject is still attracting a good deal of attention. The author has brought together all the most important facts bearing on the structure of benzol which are to be found scattered through the chemical literature of the last twenty years. He also reviews some of the symbols which have been suggested to represent it. Those which have received the most attention from chemists are the three proposed by Kekulé, Claus, and Ladenburg. After stating a certain number of facts of a chemical nature, such as the formation of benzol from ethylene, the conversion of benzol to trichloracetacrylic acid, &c., and others of a physical nature, such as the heat of combustion of benzol and the molecular volume of aromatic compounds, he goes on to considerations of a more general nature and discusses the different symbols separately, and concludes that what is known as the hexagon symbol is best in accordance with the facts observed;' he also thinks that more attention might be given to the Dewar symbol, there being one or two facts which are better explained by this than by Kekulé's, although there are others with which the reverse is the case.

CORRESPONDENCE.

DETECTION OF ANNATTO IN BUTTER.

To the Editor of the Chemical News.

SIR,—In giving a method for the detection of annatto in buttsr (CHEMICAL NEWS, lv., p. 49) I recommended testing the filtered fat, and that is a good plan when the commercial "butter colours," containing annatto colouring-matter, dissolved usually in some oil, are employed. I have, however, recently met with a butterine which gave only a very faint annatto reaction from the filtered fat, while the unfiltered fat, decanted from the water, salt, and curd, and tested as I have directed, gave a fine reaction. I noticed that the filter-paper through which the fat had been filtered assumed an orange-red tint, and on extraction with ether I got an annatto reaction from this paper.

Evidently in this case the annatto had been employed in the solid state, and much of it had not been dissolved in the fat, so that it would be well to test the clear unfiltered fat for annatto in such a case.—I am, &c.,

H. B. CORNWALL.

John C. Green School of Science,
College of New Jersey,
Princeton, June 8, 1887.

SOFTENING MAGNESIAN WATERS.

To the Editor of the Chemical News.

SIR,—The note by Mr. Wanklyn, on the above, which appeared in CHEMICAL NEWS, lv., p. 276, will lead many to believe that an analyst can frame his report so as to suit either side of a legal question.

This is no compliment to our profession, or to the common sense acumen of a parliamentary committee.

Having had a great deal to do with Clark's process of softening water, I am able to confirm Professor Frankland's opinion, so far, "that the Clark's process is not applicable to waters containing a large quantity of magnesia."

A great deal will depend on the form in which the magnesia exists in the water. Accepting the tabulated analysis of the Sudbrook water, as given by Mr. Wanklyn, as correct, we may predict that 5·4 grains carbonate of magnesia may be removed, *at least to some extent*; this will leave 6·4 grains magnesia salts, which are readily soluble and not so easily removed.

It is a well-known fact that lime water may remove the carbonates, lime, and magnesia which exist as such, by the removal of free CO_2. Now as to the other magnesia compounds, assuming that lime water, if added in large excess, may remove them, we have to contend with the important fact that the corresponding lime compounds are formed, which are soluble, and consequently the improvement of such a water is problematical.

Mr. Wanklyn says that Mr. Porter has no difficulty with magnesian waters; as I am interested in this matter, perhaps Mr. Wanklyn or Mr. Clark will say how 300,000 gallons of a highly magnesian water could be softened per diem, and otherwise manipulated so as to be fit for use.

Is Clark's process in use for softening a highly-charged magnesium water in which the magnesia exists in other forms than carbonate? and is there any other analysis of the Sudbrook water which confirms that given by Mr. Wanklyn?

The atmosphere of a committee room may be so vitiated with chemical fog, in the form of scientific conflict, that one can hardly wonder at a water bill being defeated. I know for a fact that scientific experts are looked upon with suspicion by jurists.—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove,
Forest Gate, E.

IMPROVEMENTS IN CHEMICAL ANALYSIS.

To the Editor of the Chemical News.

SIR,—The interesting article (CHEMICAL NEWS, vol. lv., p. 287) describing the advances made in chemical analysis during the past fifty years omits one method of examination which I think deserves mention. I allude to the principle of proximate analysis by the use of immiscible solvents. This method of separation has been carefully studied by Dragendorff and others, and is simply indispensable in proximate organic analysis.—I am, &c.,

ALFRED H. ALLEN.

Sheffield, June 25, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 22, May 31, 1887.

Certain Crystalline Alloys of the Platinum Metals and Tin.—H. Debray.—An alloy of platinum and tin is obtained by the action of a very dilute acid upon a mass containing about two per cent of platinum. It forms brilliant laminæ, the composition of which answers to the formula $PtSn_4$. The rhodium compound is not attacked in the cold by concentrated hydrochloric acid, and is easily obtained in small brilliant crystals of a fine metallic lustre. Its composition is RSn_3. The iridium and ruthenium alloys have a similar composition. Osmium does not form an alloy with tin.

Reproduction of a Sodium Carbonate known as Urao and Trona.—Paul de Mondesir.—The "urao" of Boussingault agrees in composition not with the sesquisalt, but with a $\frac{1}{3}$ carbonate, which the author has produced artificially.

Action of Selenious Acid upon Manganese Dioxide. — M. Laugier. — The author's researches show that selenious acid, when acting upon manganese peroxide, seems to produce, in the first place, a selenite of manganese peroxide, which, on decomposition, yields different manganese sesquiselenites. Selenious acid is not oxidised

directly by hydrated manganese dioxide, and when such oxidation ensues it forms a secondary decomposition-product.

Hydrates of Barium Chloride.—H. Lescœur.—This paper does not admit of useful abridgment.

On the Chromo-iodates.—A. Berg.—These salts appear generally as crystalline crusts, and rarely as distinct crystals. They are decomposed by water, which tends to split them up into iodates and free chromic acid. This decomposition is limited, and is arrested by the presence of an excess of chromic acid. The chromo-iodates, if hydrated, lose their crystalline water at 120° to 140°. On a further rise of temperature, oxygen and vapours of iodine are given off, and a dichromate remains. The solutions of these salts are acid. They easily yield oxygen to reducing agents. With sulphurous acid and hydrogen sulphide they yield hydriodic acid, chromium sesquisulphate, and a sulphate of the base of the salt. The author describes chromo-iodic acid, and the potassium, ammonium, sodium, and lithium salts.

The Constitution of Clays.—H. Le Chatelier.—The author, continuing his study of the clays as regards their behaviour with heat, arranges them in five groups: the halloysites, the allophanes, the kaolins, the pyrophyllites, and the montmorillonites.

On a New Betaine, Trimethyl-α-amido-butyro-betaine.—E. Duvillier.—This compound is produced by the reaction of an alcoholic solution of trimethylamine in excess (1·5 mols.) upon 1 mol. bromobutyric ether. The new compound is very soluble in water and in alcohol, insoluble in ether, and has a neutral reaction. Its chloroplatinate appears in elongated orange-yellow crystals, scarcely soluble in alcohol. The behaviour of the chloroaurate is curious. On treating the solution of the hydrochlorate with gold chloride there is formed a sort of a yellowish white precipitate, which is the emulsion of a heavy yellow oil. On boiling this oil dissolves in the water, but on cooling the liquid becomes turbid and the oil reappears, but after some hours there are formed laminar crystals, and soon the oil itself is transformed into crystals.

On Two Isomeric Mono-nitro-camphors derived from Ordinary Camphor.—P. Cazeneuve.—In the transformation of chloro-nitric camphor under the influence of copper, zinc, or iron (see *Comptes Rendus*, 1886, July 16), the author recognises two distinct isomers, the properties of which are here given.

Simplified Calcimeter.—A. Bernard.—This memoir will be inserted in full.

A Contribution to the Study of the Soil of Tunis.—H. Quantin.—The combined nitrogen in these soils ranges from 0·11 grm. per kilo. to 1·65. The phosphoric acid fluctuates from a minimum of 0·084 grm. to 1·700 grm. The chief deficiency is generally in phosphoric acid, a fact which gives greater importance to the deposits of phosphates discovered by M. Thomas.

Journal für Praktische Chemie.
New Series, Vol. xxxv., Part 4.

Researches on the Relations of Equilibrium in Aqueous Solutions.—Th. Thomsen.—In this third treatise the author considers the action of soda upon certain normal salts of sodium. He examines the behaviour of soda with sodium tartrate, and finds that by means of a large excess of soda it is possible to show the existence of a lævo rotatory compound; further, he investigates soda with sodium malate, quinate, and camphorate.

Contributions to the Chemistry of Manganese and Fluorine.—Odin T. Christensen.—The author has studied potassium chromifluoride in its anhydrous and hydrated form, potassium ferri-fluoride, ammonium manganifluoride, the corresponding sodium salt, silver manganifluoride, and chloro-purpureo-cobalt-mangani-fluoride. He further discusses the action of the hydrates of the aluminium group upon sodium fluoride.

A Critique of the Foundations and the Results of the so-called Theory of the Formation-Heat of Organic Bodies.—J. W. Brühl.—The author shows that the theory of Prof. Thomsen leads to results which conflict with much of our present knowledge of the constitution of organic compounds.

Preparation of Aconitic Acid.—W. Hentschel.—The author boils 100 grms. citric acid with 50 grms. water and 100 grms. sulphuric acid from four to six hours with a reflex condenser, and obtains, on cooling, a cake of pure crystals of aconitic acid. This is stirred up with strong hydrochloric acid, poured upon an asbestos filter, and washed to remove all sulphuric acid. The yield is from 35 to 45 grms.

Action of Phosphorus Pentachloride upon Acetanilide.—A. Michael.—The principal product, $C_8H_8Cl_2N_2$, forms large white monoklinar prisms, fusible at 116·5° to 117°, insoluble in water, and moderately soluble in cold alcohol.

MISCELLANEOUS.

Iodoform as an Antiseptic.—Iodoform has for so long been looked upon as having antiseptic properties, that any statement to the opposite effect is naturally surprising. Messrs. Heyn and Rosving maintain that these powers have been assumed but not proved, and a long series of experiments made by them brings them to the conclusion that it is not on antiseptic at all. Sterilised iodoform jelly, when inoculated with micro-organisms, was found to be full of them, all growing freely on the third day. One of these jellies was further mixed with iodoform powder, and then injected into the knee of a rabbit; on the following day the rabbit was evidently ill, and the knee much swollen. On the third day some pus was taken from the joint, and from this characteristic pure cultures were obtained.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose o giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices aa ahould legitimately come in the advertising columns.

Aluminate of Soda.—I shall be obliged if you or any of your readers can give me the address of a maker of aluminate of soda, used as a mordant and for the preparation of alumina.—W.C.L.

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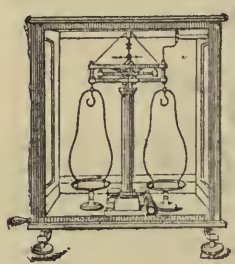

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THE CHEMICAL NEWS.

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CONTRIBUTIONS TO OUR KNOWLEDGE OF ANTIMONY PERCHLORIDE.*

By RICHARD ANSCHÜTZ and P. NORMAN EVANS.

SOME months ago† we showed that antimony pentachloride can be distilled, undecomposed, under much diminished pressure; our next step was the attempt to determine the vapour-density under similar conditions. The fact that the boiling point of antimony pentachloride lies much lower than that of the trichloride would seem to show that the vapour-density of the pentachloride, as in the case of the trichloride, corresponds to the simpler formula. Nevertheless, on account of the fundamental importance which the establishment of the simple formula $SbCl_5$ would have for the valence of antimony, it seemed indispenably necessary to make a determination of the vapour-density. We will preface our further observations with the remark that we have not yet succeeded in determining the vapour-density of antimony pentachloride under diminished pressure; however, in the course of many unsuccessful attempts which we have made to this end, we had one point thrust on our notice, which on investigation led to some important results concerning our knowledge of the chemical nature of antimony pentachloride.

Antimony pentachloride is well known to be an extremely hygroscopic body. Consequently in the application of La Coste's modification of Victor Meyer's method for the determination of vapour-densities under diminished pressure, it was necessary to substitute liquid paraffin for water; yet, in spite of numerous careful experiments, we could not attain our object, the liquid paraffin offered too great a resistance to the air, and before all the air had been driven out the antimony pentachloride distilled into the upper and cooler parts of the apparatus. During these experiments it was proved to us that it is next to impossible to prevent the formation of traces of the white substance, which is the result of the action of water on antimony pentachloride. We were accordingly constrained to put this method aside.

Before attempting the determination of antimony pentachloride by another method, we deemed it best first to find out the nature of the error caused by the formation of the minute amount of the product of water reacting on antimony pentachloride.

After careful consideration we were struck by the contradiction between the conclusions of Daubrawa‡ and those of R. Weber,§ concerning the behaviour of antimony pentachloride with water. According to the latter, antimony pentachloride forms with water a hydrate, which is impossible if with 1 mol. of water antimony pentachloride is changed in the cold to $SbOCl_3$ and 2 mols. of hydrochloric acid, as Daubrawa thinks he has proved.

The following results of our experiments show that Daubrawa's statements concerning antimony oxychloride, $SbOCl_3$, are entirely wrong. In connexion with these studies we have occupied ourselves with the action of oxalic acid on antimony pentachloride, and have succeeded in obtaining the remarkable product of this reaction in a pure state.

Reaction of Water on Antimony Pentachloride.

Daubrawa allowed 1 part by weight of distilled water to drop from a pipette into a flask, surrounded by ice, containing 16 parts by weight of antimony pentachloride. He found the decomposition accompanied by hissing, and by the formation of vapour, giving no white pulverulent precipitate, but forming a yellowish distinctly crystalline mass, which adhered to the flask. This crystalline mass, the behaviour of which with water Daubrawa describes in detail, is, according to his analysis, antimony oxychloride, $SbOCl_3$, and he expresses its formation from antimony pentachloride and water by the following equation;—

$$Sb\begin{Bmatrix}Cl\\Cl\\Cl\\Cl\\Cl\end{Bmatrix} + H_2O = SbOCl_3 + 2HCl.$$

We proceeded exactly as above described, and joined to our flask a receiver containing a weighed quantity of water in which to collect the liberated hydrochloric acid. To 21·5 grms of well-cooled antimony pentachloride, which had been purified by distillation under diminished pressure, we added drop by drop 1·2 grm., the calculated amount, of water, and found to our surprise that no hydrochloric acid was liberated; also that the yellowish crystalline product was equal in weight to the sum of the weights of the water and antimony pentachloride originally taken.

The resulting product was only partly soluble in chloroform, and was therefore a mixture of different substances.

We therefore altered the conditions of the experiment. In order to moderate the reaction we dissolved 20·4 grms. of pure antimony pentachloride in about the same volume of chloroform, and added drop by drop to the cooled solution the calculated amount, 1·1 grm., of water, shaking constantly. The formation of the new body was soon apparent by the separation of almost colourless crystals; the yellow colour of the chloroform, caused by

* A Paper read before the Royal Society, June 16, 1887.
† *Chem. Soc. Journ.*, vol. xlix., 1886, p. 708.
‡ *Liebig's Annalen*, vol. clxxxvi., 1887, p. 118.
§ *Poggendorff, Annalen*, vol. cxxv., 1865, p. 86.

the antimony pentachloride (which according to our experience is never colourless, but always a bright yellow liquid), gradually disappeared, and at the end of the reaction the crystals which had separated were covered by colourless liquid. Under these changed conditions there was again no trace of hydrochloric acid set free. We next heated our product nearly to the boiling point of chloroform, adding sufficient dry chloroform to dissolve the crystals which had separated. From this solution a compound was deposited in feathery crystals. After decanting the mother-liquor, these were washed with a small quantity of chloroform and placed to dry in a vacuum desiccator on a porous plate that had been previously heated. This body is so extraordinarily hygroscopic that the analyses were not very easy; however, the results leave no doubt that $SbCl_5H_2O$ is the formula:—

Grms.

1. 0·2719 substance gave 0·6074 AgCl.
2. 0·1457 ,, ,, 0·3270 AgCl.
3. 0·1467 ,, ,, 0·3290 AgCl.
4. 0·3003 ,, ,, 0·1461 Sb_2O_4.
5. 0·3104 ,, ,, 0·1492 Sb_2O_4.
6. 0·2020 ,, ,, 0·1061 Sb_2S_3.
7. 1·1387 ,, ,, 0·0961 H_2O } Combustion with
8. 1·3905 ,, ,, 0·1180 H_2O } lead chromate.

	Calculated for $SbCl_5H_2O$.	Found.							
		1.	2.	3.	4.	5.	6.	7.	8.
Cl	55·90	55·26	55·52	55·48	—	—	—	—	—
Sb	38·42	—	—	—	38·53	38·08	37·69	—	—
H	0·63	—	—	—	—	—	—	0·93	0·94
O	5·04								
	99·99								

We provisionally designate this body as antimony pentachloride monohydrate, without expressing any opinion concerning the constitution of this addition product of equal molecules of water and antimony pentachloride. From chloroform, the monohydrate crystallises in leafy or feathery crystals resembling sal-ammoniac, having a melting point lying between 87° and 92°. If exposed to the air it deliquesces to a clear liquid, which over sulphuric acid gradually crystallises again in broad needles, described by Daubrawa as a property of his supposed oxychloride. We have not further examined this body.

When one tries to distil the antimony pentachloride monohydrate under diminished pressure—under 20 m.m. with the bath at 105°—a mobile yellow liquid distils over; this, after two rectifications, boiled constantly at 73° under 17 m.m. (bath 90°). Two chlorine determinations gave, as was expected, results for antimony pentachloride.

1. 0·2510 grm. substance gave 0·5965 AgCl.
2. 0·2879 ,, ,, 0·6885 AgCl.

	Calculated for $SbCl_5$.	Found.	
		I.	II.
Cl	59·24	58·80	59·15

There separated from a fraction boiling somewhat higher crystals of antimony trichloride, leaving a residue of a waxy consistency which could not be distilled.

22·7 grms. $SbCl_5H_2O$ gave 12·8 grms. $SbCl_5$.
,, ,, 1·1 grms. $SbCl_3$.
,, ,, 6·4 grms. residue.
,, ,, 2·4 loss.

Although after this experience it was not probable that we could obtain antimony oxychloride, $SbOCl_3$, by heating antimony pentachloride monohydrate, we repeated the experiment in another form. We heated 24·4 grms. of antimony pentachloride, mixed with about twice its volume of chloroform and 1·4 grms. water, in a closed tube to 100° on a water-bath. The crystals of the monohydrate which were first formed went into solution, and on opening the tube before a lamp at the end of six hours we found much pressure; a gas smelling like phosgene was liberated. The tube was again closed and heated afresh to 100°. The opening and closing was repeated, first at intervals of six hours, and later, as the pressure diminished, of twelve hours, until after about fourteen days the pressure was no longer noticeable.

On working up the products of the reaction we found, besides antimony tri- and penta-chlorides, *phosgene* in solution in the chloroform, from which we prepared diphenyl carbamide, m.-p. 239°. For the formation of phosgene gas it is not necessary to work in close tubes. A chloroform solution of the monohydrate, heated to its boiling point on a water-bath, yields a steady stream of phosgene mixed with hydrochloric acid. A similar decomposition takes place when carbon tetrachloride is heated with antimony pentachloride monohydrate in a closed tube to 100°. We will communicate the quantitative relations of this reaction after we have verified our first observations by repeated research.

One can make the tetrahydrate of antimony pentachloride even more easily than the monohydrate. For this purpose we dissolved 29·3 grms. of antimony pentachloride in about twice its volume of chloroform, and after surrounding the flask containing this solution with ice, let fall drop by drop 7 grms., the calculated quantity, of water. Again, in this experiment, no hydrochloric acid was given off. The mixture remained at first liquid, but when placed in a vacuum desiccator over sulphuric acid and paraffin, there separated slowly a hard crystalline mass, which was quite insoluble in chloroform. Two chlorine determinations made after washing the substance with chloroform agree with the formula $SbCl_5H_8O_4$.

1. 0·3963 grm. substance gave 0·7696 AgCl.
2. 0·3414 ,, ,, 0·6530 AgCl.

	Calculated for $SbCl_5H_8O_4$.	Found.	
		I.	II.
Cl	47·77	48·04	47·31

Thus besides the monohydrate of antimony pentachloride a tetrahydrate also exists, the latter being easily prepared from a chloroform solution of the former by the action of water, and differing from the monohydrate among other things in being insoluble in chloroform.

From the foregoing evidence it appears that antimony oxychloride, $SbOCl_3$, is certainly not formed by the action of water on antimony pentachloride; but if equal molecules of these substances are allowed to react, the compound $SbCl_5H_2O$ is formed, which we have called antimony pentachloride monohydrate. This product is most conveniently formed when water acts on chloroform solution of antimony pentachloride, without setting free hydrochloric acid, according to the equation—

$$SbCl_5 + H_2O = SbCl_5H_2O.$$

When one brings together weights equivalent to 1 mol. of antimony pentachloride and 4 mols. of water, the tetrahydrate of antimony pentachloride is formed, as described by R. Weber. We must put aside Daubrawa's contradiction of the facts of R. Weber, and strike Daubrawa's hypothetical antimony oxychloride, $SbOCl_3$, from the list of the known antimony compounds.

(To be continued.)

PECULIAR FORMATION IN NICKEL REGULUS.

By THOMAS MOORE.

The formation referred to consists of symmetrically shaped pieces or flakes of an iron-nickel alloy, exceedingly ductile and malleable, which separate out from the molten regulus when slowly cooled. The flakes in question have a very brilliant appearance, and may sometimes be obtained one-sixteenth of an inch in thickness. Two analyses of the flakes made in 1881 gave the following results:—

	a.	*b.*
Copper	1·600	0·250
Nickel	70·300	87·863
Iron	28·300	11·865
	100·200	99·978

a. Regulus contained 13·5 per cent Fe. *b.* Regulus contained 15·6 per cent Fe.

Since the regulus from which both of the samples were obtained contained copper, another sample was recently obtained from a nickel regulus free from that metal, with the following results:—

	c	*d.*	*e.*
Nickel.. ..	86·40	72·100	73·80
Iron	13·72	2·315	4·27
Sulphur ..	none	25·506	22·01
	100·12	99·921	100·08

c. Flakes thoroughly freed from adhering regulus. *d.* Regulus surrounding the imbedded flakes. *e.* Regulus suddenly cooled to prevent formation of flakes.

Now, the strange thing in connection with this is that an absolutely sulphur-free alloy of nickel and iron should separate out from, and exist still free from sulphur in a metal bath containing at least one fourth of its weight of that element, in spite of powerful affinities, and this singularity is the more striking when it is remembered that one hundredth of a per cent of sulphur will render nickel useless as far as malleability is concerned.

I should just like to add that under favourable conditions the regulus may contain 10 per cent of the alloy.

Erdington, June 25, 1887.

DIRECT PRECIPITATION OF NICKEL OXIDE IN PRESENCE OF IRON.

By THOMAS MOORE.

It seems quite useless to attempt to precipitate oxide of nickel free from iron from solutions of the simple salts of these metals, for the simple reason that oxide of nickel is capable of precipitating ferric hydrate from such solutions. If, however, both metals are converted into the double cyanides, the iron into ferro- or ferricyanide of potassium, and the nickel into the nickelo-cyanide of potassium, then it is possible, by the action of bromine and potassic hydrate, to convert the iron into soluble ferricyanide of potassium, whilst the nickel, being incapable of forming an analogous compound, is precipitated as the insoluble black nickelic hydrate. By the simple addition of potassic cyanide to a ferric solution it is exceedingly difficult to obtain complete solution, owing probably to the formation of different cyanide compounds; if, however, a little glacial phosphoric acid be previously added a clear solution is at once obtained, which, after boiling, is not precipitated by potassic hydrate, and consists chiefly of potassic ferrocyanide, and some other red compound which as yet I have not been able to determine. Based on the above facts, I adopted the following process for the assay of nickel ores, &c., when it is necessary to estimate that metal only. The solution of the two metals is freed, as far as possible, from acids, glacial phosphoric acid (sodic pyrophosphate may also be employed) is added until the precipitate first formed commences to dissolve, and then an excess of potassic cyanide, which will dissolve the remainder and form a red or yellow solution according to the amount of phosphoric acid added. Heat the solution and keep boiling for a minute or two, adding more cyanide at intervals until a drop of potassic hydrate ceases to give a precipitate. After the solution has become cold render very distinctly alkaline with potassic hydrate, then throw down the nickel by the addition, in considerable excess, of a strong solution of bromine in potassic hydrate, then warm the liquid to facilitate the precipitation. Filter off the black precipitate and wash well out, dissolve it off the filter in warm dilute sulphuric acid, and after saturating with ammonia, deposit the nickel electrolytically from the warm solution. Any cobalt present remains with the iron, but manganese will be found in the nickel solution completely or partly deposited on the opposite pole as oxide according to the amount present. Beneath are a few of the results obtained.

Taken. Fe.	Ni.	Found. Ni.
0·100	0·0990 grm.	0·0995 grm.
0·400	0·0990	0·0985
0·075	0·1315	0·1320
0·333	0·3197	0·3210
0·666	0·3200	0·32075
0·250	0·6550	0·6538

Erdington, June 25, 1887.

ANALYSIS OF VINEGAR.

By B. F. DAVENPORT, late Vinegar Inspector for Boston.

The following detailed practical method of determining whether a sample of "cider vinegar or apple vinegar" conforms to the requirements of the statute relating thereto, which requires that it should be not only the legitimate and exclusive product of pure apple juice or cider, but also that it should not fall below the quality of possessing an acidity equivalent to the presence of not less than 4½ per cent by weight of absolute, that is monohydrated, acetic acid, and should yield upon full evaporation at the temperature of boiling water not less than 2 per cent by weight of cider vinegar solids, may prove of interest to those dealing in the article. As the limits set by the statute are in per cents by weight, the portion of vinegar taken for the tests should, for perfect accuracy, be also taken by weight, that is the quantities of 6 and of 10 grammes are to be taken for the tests of strength and of residue, but as taking it by measure, if of about the ordinary atmospheric temperature of 60° to 70° F., will make the apparent percentage at most only 1 to 2 per cent of itself greater than the true, that is will make a true 5 per cent vinegar appear to be, say, from 5·05 to 5·10 per cent, measuring proves in practice to be accurate enough for all common commercial purposes, and therefore the quantities of 6 and of 10 cubic centimetres by measure may be taken in place of as many grammes.

All the measuring apparatus necessary for making the legal tests is one of the measuring tubes, called burettes. It is most convenient to have this of a size to contain 25 to 50 c.c., that is cubic centimetres, and have these divided into tenths. The best form of burette is the Mohr's, which is closed by a glass stop-cock. Besides this only a dropping-tube, called a pipette, graduated to deliver 6 and 10 c.c., will be needed. These tubes are to be obtained of any philosophical or chemical apparatus dealer, being articles generally kept in stock by them for common use, like yard sticks.

The only two chemicals needed in determining the strength of a vinegar are such as can be obtained of any competent apothecary in any city of the State. They are simply a small vial of a 1 per cent solution of phenolphthalein in diluted alcohol, and a sufficient quantity of a solution of caustic soda, prepared as directed for "Volumetric Solution of Soda," upon page 399 of the last "U.S. Pharmacopœia," a book which is in the hands of every competent apothecary, as it contains the formulæ according to which he is required by the law of the State to prepare all such medicinal preparations as are mentioned therein.

Having these, the procedure for making the test will be as follows:—Fill the pipette by suction and then quickly close the top of it with the forefinger. Raise the tube out of the sample of vinegar and let it empty out by drops exactly down to the top graduation mark. This bearing the mark of 0 c.c. Then holding it over a white mug or cup let it run out exactly down to the 6 c.c. mark. Dilute the 6 c.c. of vinegar, thus measured out into the mug, with sufficient clean water to make it look about white, and then add to it about three drops of the phenolphthalein solution. Then, having prepared the burette by filling it up to the top, zero, or any other noted mark of the graduation, with the volumetric solution of soda, let the soda solution run out cautiously into the diluted vinegar, which should be constantly stirred about. As soon as the vinegar in the mug begins to darken the soda should then only be allowed to run into it by drops. This dropping is thus continued until at last a final drop of soda turns the vinegar suddenly to a permanent pink or cherry colour, which will not disappear upon further stirring. By now reading off from the graduations of the burette the number of full c.c. divisions and of tenths which have been emptied out to bring about this change of colour in the vinegar is known the per cents and tenths of acidity equivalent to true acetic acid contained in the vinegar being examined. This, if it is a pure cider vinegar and well made, will be upon the average about 6 per cent, but never under 5 per cent. If in like manner 10 c.c. of the vinegar is exactly measured off by the pipette into a small light porcelain dish, and then evaporated fully to dryness over boiling water, the number of grammes weight gained by the dish, when multiplied by ten gives the percentage of solid residue contained in the vinegar.

There are certain characteristics peculiar to the residue of a pure cider vinegar, the principal of which are the following:—It will be about 3 per cent in weight, and never less than 2 per cent. It is always soft, viscid, of apple flavour, somewhat acid and astringent in taste. A drop of it taken up in a clean loop of platinum or of iron wire and ignited in a colourless Bunsen gas lamp flame, imparts to it the pale lilac colour of a pure potash salt, without any yellow due to sodium being visible. The ignited residue left in the loop of wire will be a fusible bead of quite a good size, and it will leave a strong alkaline reaction upon moistened test-paper, effervescing briskly when immersed in an acid. The presence in a vinegar of the slightest trace of any free mineral acid will prevent the ignited residue leaving any alkaline reaction, or effervescing with acids. The presence of any practical amount of commercial acetic acid added, to "tone up" the strength of the vinegar, will cause the igniting residue to impart another colour to the Bunsen flame, and the residue itself will have a smoky, pyroligneous taste or odour. Any corn glucose used in the vinegar will cause its residue when ignited to emit the characteristic odour of burning corn; and as the last spark glows through the carbonised mass, to usually emit the familiar garlic odour of arsenic. For the common oil of vitriol usually used in the production of glucose is now mostly derived from pyrites, which almost always contain arsenic. A glucose vinegar which has been made without vapourising the alcohol after the fermentation of the glucose will also have a strong reducing action upon a copper salt in an alkaline solution, and also will give a heavy precipitation of lime with ammonium oxalate. A true malt vinegar always contains phosphates, and a wine vinegar cream of tartar. The presence of any acrid vegetable substance in a vinegar is known by the residue having a pungent taste, especially if before the evaporation the vinegar has been exactly neutralised with soda.

In a pure apple cider vinegar hydrogen sulphide gas will not cause any discolouration, nor will the addition of a solution of either barium nitrate, silver nitrate, or ammonium oxalate cause anything more than the very slightest perceptible turbidity. But the addition of some solution of lead acetate—that is, of sugar of lead—will cause an immediate voluminous and flocculent precipitation, which will all settle out in about ten minutes, leaving a clear fluid above. In most of the so-called "apple vinegars" brought into this market from other States the addition of some of this lead solution will cause but a slight turbidity, without any precipitate settling out for several hours, and even then the precipitate will not be of the same appearance as in apple cider vinegar.

Sophistications of cider vinegar that will not be detected by some one or more of the above given tests are not likely to be met with, for the simple reason that they are not profitable. To translate percentages of acid strength into the old commercial terms of grains of soda bicarbonate per troy ounce, the per cent may be multiplied by 6·72; or, *vice versa*, divide the grains by the same factor. To reduce it into grains of potash bicarbonate, 8 would be the factor to be used in like manner.

ON A METHOD OF ILLUSTRATING THE PERIODIC LAW.

By W. SPRING.

In Part 15 (vol. xix.) of the *Berichte* is described a method of illustrating the Periodic Law by J. Emerson Reynolds.

The writer begs to state that he has employed this method for the last six years in his lectures on general chemistry at the University of Liege. For this purpose he has had tables lithographed (Vaillant-Carmanne, of Liege) representing the undulations of the periodic system, and he forwards to the German Chemical Society copies of the first and the second edition of his tables (1881 and 1885).

As it is his intention to develop his method at large, showing that not only the great and small periods but the relative energy of the elements can thus be illustrated, this claim of priority is evidently justified.—*Berichte der Deutschen Chem Gesellschaft* (Vol. xix., p. 3092).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 25th, 1887.

Shelford Bidwell, F.R.S., Vice-President, in the Chair.

The following communications were read:—

"*Note on Magnetic Resistance.*" By Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S.

In the spring of 1886 the authors made experiments on the magnetic induction through horse-shoe electromagnets when excited by constant currents. The inductions through different armatures and air-spaces were also measured. The results show that, for small exciting powers, the law of parallel resistances is true for magnetism, taking leakage into account. From experiments

made with two electro-magnets, the poles of which were placed at different distances apart, the authors conclude that the magnetic resistance of air is proportional to length, or to length plus a constant.

A note on Magnetic Resistance was read before the Society on March 12th, 1887, by the same authors, describing experiments on two iron rings, one whole and the other divided by a radial saw-cut. Since then the experiments have been repeated with great care by Col. Swinton and Mr. Sorënson, of the Central Institution. The resulting curves agree with those previously obtained. On measuring the air-space it was found considerably less than estimated, and the magnetic resistance of air relative to iron (assuming no "surface resistance") comes about 1500. Experiments made with different air-spaces, together with the above, seem to show a considerable "surface resistance."

Prof. S. P. Thompson thought dynamo-makers had evidence of such "surface resistance," from the care exercised in avoiding joints in the magnetic circuit wherever possible; and Mr. Bosanquet mentioned some experiments he had recently made on the resistance of joints during the various stages of fitting. The changes of resistance are very large, and he concludes that, however good the fit, it is not possible to reduce the surface resistance to a negligible quantity.

"*On Sounding Coils.*" By Prof. W. Stroud, D.Sc., and J. Wertheimer, B.Sc.

The paper describes experiments on coils and helices of wire which emit sounds when variable electric currents are passed through them. The pitch depends on the frequency of the current variations. The authors believe the sounds due to the attractions of adjacent parts of the wire, which cause shortenings and lengthenings as the current increases or decreases. To prove this two identical coils were made, and one of them embedded in plaster of Paris. This gave no sound when the variable current was passed, whilst the other emitted the usual note. It was also found that no sound could be got from a single turn of wire, whilst one and a quarter turns gave an audible sound under the same conditions.

"*On Comparing Capacities.*" By Mr. E. C. Rimington.

This is an investigation of the conditions under which the integral current, through a galvanometer in a balanced Wheatstone's bridge, is zero, when the battery circuit is broken,—two adjacent arms, A and D, of the bridge being shunted by condensers of capacities, K_1 and K_2. It is shown that—

$$\frac{K_1}{K_2} = \frac{C}{B}$$

where C and B are the resistances of the arms opposite to A and D respectively. If A and D be made infinite the necessity of balancing for steady currents is obviated, but if either of the condensers has an appreciable leakage, corrections are required. The best resistance to give to the galvanometer is shown to be—

$$G = \frac{B(C+D)}{B+C},$$

and the conditions under which a telephone may replace the galvanometer are—

$$\frac{K_1}{K_2} = \frac{C}{B}.$$

The case where all the arms have self-inductions is investigated.

"*On the Effects of Change of Temperature in Twisting or Untwisting Wires which have suffered Permanent Torsion,*" By Herbert Tomlinson, B.A.

The author's attention was re-directed to the subject by the note read by Mr. Bosanquet on May 14th. Some eight years ago he made experiments on such wires, and regards the effects due to changes produced in the thermal expansibility of the metals, by permanent elongation or compression. Thus if a small square be drawn on the surface of a wire, and the wire subjected to permanent torsion, the square becomes a rhombus, the longer diagonal of which suffers permanent extension and the shorter diagonal permanent compression. If permanent extension causes an increase in thermal expansibility and compression a decrease, then a rise of temperature will cause the wire to twist more, and *vice versa*. With annealed iron wires which have suffered permanent torsion, remarkable effects take place at about a red heat. In heating such a wire it untwists slightly until a bright red heat is attained, when a sudden twist takes place. On cooling, a sudden untwist occurs at about the same temperature. These effects have been previously observed by Prof. Barrett, who believes them to be connected with the sudden changes in the magnetic properties of iron, and to take place at the same temperature. This latter conclusion was found to be erroneous, for the author exhibited experiments showing that the magnetic change takes place at a temperature decidedly lower than that at which the jerks above referred to occur.

"*On Permanent Magnet Ammeters and Voltmeters of Invariable Sensibility.*" By Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S.

The sensibility of ordinary permanent magnet ammeters and voltmeters increases as the strength of the magnet decreases, whereas in those of the Depretz D'Arsonval type (in which a suspended coil controlled by torsion swings between the poles of a permanent magnet) the reverse effect takes place. By combining the two systems the authors have devised instruments whose sensibility is unaltered by changes in the strength of the magnet. The torsional control of the D'Arsonval is removed, and a small permanent magnet attached to the swinging coil. As the large permanent magnet changes, the controlling and deflecting forces change in the same proportion, and the deflection for a given current remains unaltered.

UNIVERSITY COLLEGE, LONDON.

Chemical and Physical Society.

Dr. Williamson's Farewell Address.

The following Address was given by Professor A. W. Williamson, F.R.S., at a meeting of the Chemical and Physical Society, on Thursday, June 16th. Prof. William Ramsay, Ph.D., occupied the chair, and a large number of visitors, including Prof. Odling, Dr. W. J. Russell, Dr. George Buchanan, and Prof. Carey Foster, were present.

It is useful now and then to pause in one's work among the multifarious details which commonly engage our attention, and to look somewhat from a distance at the general outline of things which one may have been working at, but more especially at the outlying parts of the country, in one corner of which one may have been working. Of course it is necessary to divide the work of science into many compartments, and it does sometimes happen—I suppose it not unfrequently happens—that for a while one does not look so much at the neighbouring provinces and at the glorious territories which are being developed, as one does at what has been doing in one's immediate vicinity. I think that with regard to chemistry it may perhaps not be less important than in other portions of the domain of science to forget now and then a good many of the multifarious particulars which have been accumulated, and to look a little at the general results which have been arrived at in what I have just now called the neighbouring provinces, and to see how far those results have a bearing upon what we have been doing. And if science is in its nature one, and if we are by degrees to rise to more general conceptions of the order of nature, I conceive that it is not one of the least important operations that one should, from time to time, endeavour to learn the chief bearings of the surrounding

country, and to see how they stand in relation to the landmarks in one's own particular province.

The country which I am thinking of at the present moment as adjacent to chemistry is one between which and the department of chemistry the border line would be difficult to trace. I believe that our forefathers of Great Britain were benefitted by the existence of that debateable land in the north between Scotland and England. When one reads of the daring deeds of those border men, and of the energies which were developed in the practical discussion of questions of boundary with which they were very particularly engaged, one is inclined to think that such exercise of their energies may have been conducive to a development of those energies, and to a benefit to both these districts between which the border-land lay, by raising up men who looked to the one and to the other, and not merely to one. Now, of course, in our work of chemistry we do work at many things which concern the workers in physics, but the general treatment of those subjects is, in some respects, and commonly has been to a great extent, peculiar to them.

Now, amongst our results there is one — if I may be permitted to call it a result—which I venture to think constitutes an important landmark, established by the work of chemists in the advancement of knowledge. It is what is commonly called the atomic theory; and perhaps, in speaking of that, it may be desirable that I should in one word state what I mean by "theory." A scientific theory, I suppose, ought to be the most condensed statement of general facts: and I take it that the atomic theory is that. To me it is nothing more. I do not use atomic reasoning, or refer to considerations relating to the atomic operations, otherwise than as indicating limits which exist to our efforts to break up matter. Whether we like them or not they exist. There are many thinkers who prefer overstepping that boundary, and discussing aloud, as well as considering silently, what there may be beyond it — whether, for instance, these limits by which we are stopped at present, and which I think that it is well to recognise as existing in our present state of knowledge, may not be overstepped. As a chemist I have nothing to do with that. There is a border-land which is, perhaps, like the other border-land of which I have spoken. Its existence is not only natural, but may possibly be useful. I am far from deprecating the exercises which are not strictly scientific, which are not based upon actual well-established facts and reasonings, and which are not conducted on the most rigorously irreproachable method—reasonings, in fact, in which the imagination plays a somewhat greater part than it does in the ordinary routine of scientific work. And therefore, when I say that as a chemist I have nothing to do with speculations as to the decomposition of atoms, I merely wish to recall what I conceive to be the real solid ground upon which by generalisation the atomic theory stands.

Now, whilst we chemists have been working away (and the number of us who are working at it is marvellously great and wonderfully increasing) at examining chemical changes and putting on record new observations which have been elicited by carefully-conducted experiments regarding those chemical changes, there have been others who have taken up many of the results at which we have arrived, and have considered them from a point of view with which we, as chemists are, I may say, scarcely at all occupied. Of course the chemist may know something more than chemistry, and in most cases it is very desirable —perhaps more than desirable—that he should do so. But I mean that in his purely chemical work he has not to do with determinations of the kind which in physics constitute essential results—in fact, the main body of the work. And amongst these results there is one which certainly is exceedingly prominent, and amongst the recent triumphs of the human intellect, and the careful, methodical work of science, certainly not one of the least noteworthy. It is that the physicists have taken particular cognisance and have begun the careful study of certain groups or clusters of atoms which we have noticed and described, and regarding which we have establish various important facts.

Now I think that it is fair to acknowledge, with regard to our brethren in the neighbouring province of physics, that it is to them that we owe mostly the study of the motion of these clusters of atoms as I have called them. But I ought perhaps to call them, to adopt the common term, molecules.

The knowledge of certain very simple laws appertaining to that motion is a triumph of work in physics of which this generation may justly be proud. I do not think that I am wrong in saying that the fact of their moving, and the bearing upon other truths of that circumstance, has not as yet occupied as much of the attention of chemists and of other workers as I venture to think it may be destined to occupy from its natural importance and from its fundamental character.

Chemists have had occasion to study and are still studying cases in which individual atoms move; indeed most of the chemical reactions which they examine are proved to be due to interchange of atoms between molecules. Take any one of the very simplest of chemical reactions you like. Take the precipitation of a silver salt by a soluble chloride. Noting merely the most elementary facts regarding those substances we observe that when we mix them in a fluid so that they can act upon one another conveniently a change of place occurs between one kind of matter and another kind of matter—between the silver in the one compound and the metal in the other. They change places.

One of the first and most fruitful sources of our information about elementary atoms was the consideration of the relative weights of the different kinds of matter which thus change places.

Not a year passes without a great number of new compounds being made by the assiduous labours of skilled experimentalists. Brief outlines of these researches annually fill an enormous volume. Most of these compounds are made by processes of atomic interchange between molecules, or of the interchange of groups of atoms which behave like individual atoms—in fact, by processes of atomic motion.

It was stated long ago by Berthollet that when two salts in solution are capable by interchange of constituents of forming a precipitate, such interchange takes place and the precipitate is formed.

The point is of some importance, and therefore perhaps it might be well that I put it not only in that way, but in some other which I will endeavour to find so as to make sure that we have the conception clearly before us. The formation of a precipitate was stated—and *primâ facie* very reasonably stated—to be a test of whether the particles could move so as to form it. Thus, if by interchanging their metals, for instance, two salts in solution would form some insoluble body, then we might be sure that such interchange would take place. Now this statement is true with exception of certain rare cases where circumstances interfere with the process; and certainly any statement which thus connects a vast number of phenomena, and which does correctly correspond in the main with the realities with which it professes to deal, must be of some considerable value. But another circumstance about it is that a cause was invented to explain this regularity. An interchange which produces a precipitate was supposed to be due to an inherent force in the materials to move in such manner if by so doing they could form a precipitate. This inherent force was called "pre-disposing affinity." It has often happened that those who discovered some regularity in nature previously unknown have thought to explain it by supposing some special force to have been at work, and have invented a name to describe the imaginary force. So in the earlier stages of civilisation men endeavoured to explain the occurrences of nature by supposing external objects to be endowed with will and power of discrimination.

The term "predisposing affinity" implies that the particles were in some way predisposed to do this particular thing which they were found to do. I think that the term conveys that idea, and can hardly be separated from it. On reflecting upon the state of such particles which are "predisposed," and following out rigorously the idea which is thus suggested, I must confess that I have felt at a loss to know how the particles could judge of the cases in which their disposition could find vent, and distinguish them from the other cases in which their best intentions would not bring about such a result. Take the case of the chlorine and the silver in the two compounds which I have mentioned. If they are "predisposed" to combine, they can only do it if they form a precipitate; and how are they to know that the compound will be insoluble? I have heard it compared to a game which I suppose that most of us have played in our youth—the game of "puss in the corner." The change of place that takes place between two of the moving atoms—if you will allow me to call them so—is the result of some interchange of symbols. "Will you change place with me, for if so, I am ready to change with you." But in the case of the chemical reaction there would need to be something more than that. There would need to be some valid ground for believing that a result of a particular kind would ensue from the change of place if it occurred.

It would, however, be remarkable that particles should only move in this manner under the particular conditions indicated by the general law. Those who have paid even slight but careful attention to the elementary facts of physics are aware that there are a great number of circumstances which cause a communication of motion or vibration to matter in its various forms. Thus the molecules of liquids, even when apparently at rest and in a state in which they undergo no change—are in a state of constant motion. The phenomena of liquid diffusion afford an illustration of such molecular motion. These phenomena do not, however, afford us any direct evidence of the interchange of atoms between molecules.

Perhaps it may be convenient that I should allude next to a simple case which is now well known to chemists. I shall not go beyond the most elementary commonplace facts, because they afford the surest footing for generalisation.

There is a group of atoms called ethyl which in its chemical behaviour was long known to be very much like a single atom. It was very much like hydrogen in its nature, and it has been shown by very simple and direct experiments which are not at all difficult to verify that when a compound of ethyl—the particular compound called alcohol—is mixed with a hydrogen compound, also fluid, called oil of vitriol, the two bodies do not continue unchanged while in contact with one another. The atoms of ethyl in the alcohol change places with the atoms of hydrogen in the oil of vitriol. There is no precipitate formed. It is a case in which there is a movement, a change of place, of the same kind as that which in the class of phenomena I was alluding to would have produced a precipitate.

The atomic motion is the same, but it takes place certainly without that "predisposing" cause. It is, moreover equally well known that when we have water and sulphovinic acid (the products of the atomic interchange just mentioned) mixed with one another, an interchange of ethyl with hydrogen takes place between those compounds producing alcohol and oil of vitriol. Alcohol and oil of vitriol by an atomic interchange between ethyl and hydrogen form water and sulphovinic acid; these products by interchange of hydrogen and ethyl reproduce alcohol and oil of vitriol.

In these cases we have not indication of atomic motion such as are afforded by the formation of precipitate, or by any other visible sign. The atomic interchanges are only proved to have occurred by careful chemical investigation.

These cases in themselves prove that atomic interchange between molecules are not confined to reactions like those in which they were previously recognised. There are many other cases in which chemical investigation has enabled us to determine the state of combination of the constituents of molecules similarly present in a mixture which shows no external indications of change, and in all these cases, as far as I know, it is proved that similar atomic interchanges occur.

In the study of natural phenomena a similar order in the development of our knowledge has often occurred. It happened in geology that men attributed to exceptional influences the occurrence of changes of a very striking and permanent character; and it is, of course, well known that that truly great philosopher Lyell had the merit of showing that all those known changes were the result of quiet processes of gradual change which were constantly going on, sometimes more rapidly then at other times, and were due to continuous action of the forces of nature. Then, again, with regard to biology, we have had of recent years a perfectly similar result before us. Instead of supposing, as we did, that exceptional circumstances caused the occurrence of particular species and of varieties in the animal and in the vegetable kingdom, we now know these great differences are the result of that silent and continuous action of the natural life processes as influenced by external conditions.

In each of these cases the prominent phenomena which first attracted attention were ascribed to the occasional and spasmodic action of special influences, but further investigation showed them to result from the nominal action of influences which were continuously at work. Atomic interchanges between molecules were known to take place in cases where their results showed themselves prominently and readily, and were attributed to predisposing affinity which caused their occurrence in these particular cases.

We now know that atomic interchanges take place without giving any indications of the kind previously noticed. In illustration of the variety of cases of such interchanges of which chemical evidence has been obtained a few cases may be given beyond those already mentioned.

Thus, a solution of potassic hydrate in alcohol contains potassic ethylate and water, as proved by various tests, and reciprocally a solution of potassic ethylate and water contains alcohol and potassic hydrate.

A solution of chlorine in water is proved by many of its properties and reactions to contain hydric chloride and hydric hypochlorite, and reciprocally, a mixture of the concentrated solutions of those bodies is partially decomposed with formation of chlorine and water.

When the products formed by the interaction of liquid substances happen to be themselves liquid, it has been pointed out that we find that by the reaction upon one another of these products the original materials are reproduced as fast as they are decomposed, and the equalisation in the composition of the mixture is established, but when one or both of the products happens to be solid, and consequently unable to react readily, if at all, upon the other product, this reproducing change does not occur, and the decomposing change completes itself.

To make it more clear I may be permitted to give a little more precise statement, so as to avoid any possible mistake. I may take for that purpose, say a potassium salt and hydrogen compound. Suppose that we have common saltpetre—nitrate of potash—and hydrochloric acid. I say that when they are present the potassium in the one compound does change places with the hydrogen in the other, forming hydric nitrate and potassic chloride. And those two salts, like any other salts, when they are present also interchange reproducing the original materials, so that there is going on in such a mixture, not only a process of what I may call decomposition and change, but also a reproducing process. That is what occurs when, as in the case which I have mentioned, the products which are formed by the decomposing change remain

fluid and are able to interchange the particles back again so as to reproduce the original materials.

The next point is that when we have got these products changed they have got properties of the same kind. In contact with one another they undergo a similar process. The atoms change places naturally and reproduce the original compounds. But if, as in the case which I first took, we happened to have taken two compounds of a kind which could not form a soluble body, but which formed an insoluble one, as in the case of the silver salt and the hydric chloride, then this decomposing change would take place; but the silver, when it got into juxtaposition or intimate contact with the chlorine, would form a compound which is insoluble, which cannot dissolve in the liquid. And so it falls to the bottom, so that it does not come in contact with the other compound; and even if it had a predisposing affinity to form the original compound again, it would not be able to do it. The formation of precipitates presents itself, according to this more general conception, as the result in those particular cases in which one or more of the products which are made happen to be of such a kind that they pass out of the sphere of action of the other compounds. It is one result of a process which occurs in all cases of chemical reaction, the result of a uniform influence which is not peculiar to those cases.

I should like to give, if you will permit me, one or two other very elementary cases which are noteworthy, because they do not strike one, and they are not so much in the ordinary course of elementary testing. They have, perhaps, a peculiar interest as showing how the principle applies itself to cases somewhat different in form. And that brings me to the consideration of the condition of substances when they are dissolved. We are accustomed, and, I think, naturally enough accustomed, in the first instance, when we have no evidence to the contrary, to suppose that if we dissolve any particular substance in water the substance is there—that the same substance which was put into the water is there, and that the water is also there.

One does not, for instance, feel any motive or any ground for imagining that in the process of solution they have undergone change. One of the commonest cases of the kind is the case of chlorine gas. Chlorine is one of the commonest and best known of elementary gases, and when it is dissolved in water it is well known to possess properties which chlorine itself does not possess. For instance, chlorine may be brought into contact with a colouring matter called litmus, without any change taking place. For some time I had a jar which was kept closed, and contained very dry chlorine. There was a piece of blue litmus in it, and the litmus retained its blue colour, for I do not know how many years, until in process of time the jar got a little leaky and a little moisture leaked in, and the litmus gradually lost its colour. The chlorine in the presence of the moisture produced that effect which does not belong to chlorine itself. In like manner it is well known that chlorine itself does not produce various other effects which its mixture with water produces. For instance, if you shake up chlorine with water containing carbonate of lime—chalk—we find that an action takes place in which the chlorine behaves in two ways. Part of the chlorine passes one way and forms one compound, and another part of the chlorine—precisely half of it—passes another way and forms an entirely different compound. Now I think that to anybody—even to those who have not attended particularly to chemical phenomena—it would seem strange that if you pass chlorine gas, which is homogeneous, into a mixture, one-half of it behaves in an entirely different manner from the other half. An analysis of the process has shown that the result is due to this fact, that the chlorine in the presence of water is reacting on the water. We know that chlorine—I am not now expressing any opinion, but merely a fact perfectly familiar to all chemists—the so-called free chlorine consists of a cluster of two atoms united together—combined chemically. The smallest quantity which we could get would be a couple of atoms linked together.

$$\begin{array}{c|c} Cl & Cl \\ H & OH \end{array}$$

This chlorine, when it is in contact with water, consists in part of these two products which I have marked off by the dividing line. One-half of the chlorine is in combination with an atom of the water and has taken it out, and the other part of the chlorine has passed into combination with those elements with which that atom of hydrogen was combined. I think that we may as well describe it as an atomic interchange. It is merely a difference in form. I have represented it by a dividing line. It is a substitution in which you have got all the so-called element which we recognised some years since to consist of a couple of atoms united together. When we have got them in contact with water, an interchange goes on between half the chlorine in many of those atoms of chlorine and many of the atoms of the hydrogen in the water.

But that is not all. I gave another illustration just now. The power of this liquid to dissolve carbonate of lime is a property which does not belong to chlorine by itself. It belongs to the hydric chloride, which is formed in this manner according to the interchanges which I have indicated. That fact that this chlorine in water absorbs chalk, and forms the compound which hydrochloric acid forms with the chalk, shows that hydrochloric acid is there. And then we find also as a product the peculiar bleaching body, of which the formula is HClO.

This is the other part of the reaction which I have previously mentioned. I mean that it is this which causes chlorine in the presence of water to bleach.

I ought, however, in order to supplement this statement, to give the counterpart of it, because I think that you will probably have perceived, although I did not expressly state it, that if you bring two substances together, and if the decomposing change were to go on and not to be balanced by something else, the whole substance would be decomposed, and not a part of it. For instance, in the case I took of the alcohol and the oil of vitriol, we do not find that ethyl and hydrogen all of them change places. We find that certain proportions of them change places. And it depends on how much you have of the sulphuric acid and how much of the alcohol, what that proportion is; whereas if there were only a tendency to interchange in that one direction, so as to decompose the substances originally put in, then the decomposition would complete itself, and you would have no ethyl left—at all events, those atoms which were present in the smallest number would disappear from the compound in which they were. But what we do find is that in each case of the kind there is a certain balance. When once the decomposition or the atomic interchange has gone a certain way, then it goes no farther. There is no greater quantity of either product formed on longer standing. Not only do those materials react on one another and cause a decomposing change to take place, but that the products when they are formed, also react on one another, and cause a reproducing change to take place.

Thus, when you take a mixture of chlorine and water, in which by experiment you find that a definite proportion of the molecules of chlorine and water have reacted on each other in the manner described; this equilibrium is due to the fact that in each unit of time as many molecules of the materials are decomposed (by the mutual interchange of atoms) as are reproduced by the corresponding interchange of atoms between the molecules of the products.

I take this particular case, but I might adduce many other similar cases. That there is such constancy as soon as the particles have been together long enough to have had time to arrive at that equilibrium, is an elementary fact which is a matter of experiment. A great many cases of anomalous results become clear. In my own small experience I may mention some things which seemed to

look certainly remarkable and inexplicable until I looked at them in the light of this process, which, I believe, is of universal occurrence, and certainly no limit to it has been assigned. For instance, take the case of alcohol. Organic bodies have the advantage that the interchange is slower, and it is more easy to arrest the products formed by them without their changing back again, so that we can catch them in the state in which they were. The very illustrious French chemist, Balard, was a man remarkable for his loyalty, and the incident which I am about to relate is certainly typical of that. One dwells with pleasure upon it. Balard made an experiment for the purpose of preparing a particular body combined with an organic radical called amyl. He thought that he would get the oxide of amyl, and the process which he adopted was, according to the ideas which then prevailed, an exceedingly reasonable one, and one which could hardly have failed, if those ideas had been correct, to lead to the result in question. He dissolved potash in alcohol, and he treated the solution with the chloride of amyl, and he thought, according to the idea that then prevailed, that potash was simply an oxide of potassium, and that when it was dissolved in alcohol it ought to be oxide of potassium and was not combined with the alcohol in any way. Well, he get a body which was perfectly different. He burnt it, he analysed it, and he has published the results of his analysis, which did not agree, even approximately, with his anticipation. Afterwards, attention was drawn to the fact that the solution of potash in alcohol did contain the potassic hydrate which had been put into it, but it also contained a compound (C_2H_5OK) formed by the atomic interchange between the potassium of this potassic hydrate (HOK) and hydrogen of the alcohol (C_2H_5OH); and it is this compound that is acted upon by the chloride of amyl. It is well known that if you pass carbonic acid into it you get a compound of it with the carbonic acid. You get a compound of it with the potash because there is always some of the potash left, but you also get a compound (carbovinate) of the carbonic acid with the potassium-alcohol.

I have given this case, and it would be wearying you, I think, if I were to go into many other such cases. There would be a great sameness in the results which they afford. But as far as I know, whenever we have the means of ascertaining the condition in which substances are present in solution, we find evidences of such atomic interchanges. I do not know a single case in which, from a wider view of things, one can affirm that it is not so.

It may be desirable to test the generality of the law by briefly considering some simple cases of aqueous solution of salts. I do not think that it would be reasonable to expect one to be able at once to show the application of a new theory to all the cases to which one would conceive it applicable. Careful and prolonged study is required to work out its application in the various forms which present themselves. Common salt when dissolved in water must be expected to be present partly in the form of the salt and water—partly in the form of products formed by the interchange between the salt and the water with which it is in contact.

I feel convinced that when salt dissolves in water there is going on between the constituent atoms, the sodium atoms in the salt and the hydrogen atoms in the water, an interchange forming hydric chloride and sodic hydrate, and that there is also going on an interchange between the corresponding atoms of those products which is reproducing the original substances. Now if, as in that case, the substances which you mix are of very stable equilibrium, little prone to undergo change, then we should expect from the general law to find that the number of molecules of the original salt and water present must be enormously great compared to the number of molecules of the products formed by their mutual reaction, because these materials react very slowly on one another, so stable are they; and in order to form in a unit of time the given number of the products equal to those that are formed by the reproduction they must be present in great numbers compared with the other. Thus if, when the composition of the mixture has become constant there were a thousand times as many molecules of the materials (salt and water) in solution as of the products of their mutual reaction (sodic hydrate and hydric chloride), then there are in a unit of time as many decomposing interchanges between a thousand molecules of salt and water as there are of reproducing interchanges between one molecule of sodic hydrate and hydric chloride; or what is the same thing, the acid and basic substances react a thousand times as fast as salt and water.

In order to understand the chemical behaviour of particular substances it is always desirable not to limit one's view to any one of them, but, as far as possible, to group together with its substances which we know to possess a close analogy to it. Compounds of ammonium are known to possess a close analogy with those of potassium. Ammonic chloride dissolved in water must be in the main like, and must obey the same law, and could not be expected to be in its nature different from potassic chloride. The solution is found to contain the products of the action of the salt on water, for by mere boiling the ammonic hydrate that is in it gives off ammonia gas, and hydric chloride is left in the solution. Another well-known salt, magnesic chloride, when dissolved in water, forms a solution which appears homogeneous, and presents no external indication of containing any products formed by atomic interchange; yet the water cannot be driven off so as to leave the salt, for it is well known that hydrochloric acid which is present in the solution passes off with the vapour of water, leaving a basic salt.

Again, take ferric chloride; here we have evidence that nearly all the chlorine in the salt passes off in the form of hydric chloride, leaving ferric oxide mixed with a little of the salt. Again, there are other cases in which we are not accustomed to consider that the salt dissolves at all. Yet in their essential features they are processes like those in which we do. For instance, there is a liquid chloride of phosphorus which, when we throw it into water, acts with great violence. It is in its constitution like chloride of antimony, and, like many other chlorides which we are in the habit of speaking of as dissolving as such; yet we note with regard to it that the water contains chiefly the products of interchange with water. In fact, when we evaporate we cannot recover any of the original material. In considering these phenomena it ought not to be forgotten the decomposition of substances is the process commonly resorted to in order to render them soluble—bone earth is dissolved by hydric chloride by a process of decomposition; lead sulphate is dissolved by potash in like manner. Chemistry abounds with similar examples. I have only mentioned these few cases in order to afford illustrations of what I believe to be a general truth, that if, instead of confining our attention to the facts before us in one particular case, like that of the solution of potassic chloride with water, we take a wider horizon and consider, side by side with that, what occurs in the case of bodies different in their composition, but analogous in their general nature, we get clear and unmistakable evidences of that fundamental process which I affirm takes place in all, and it would be difficult to suppose that solution of the potassium salt takes place by an entirely different process to that which is found to occur in other cases.

Professor RAMSAY and Professor CAREY FOSTER proposed a vote of thanks to Professor Williamson.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, July 4, 1887.

HENRY POLLOCK, Esq., Treasurer and Vice-President, in the Chair.

THE following gentlemen were elected Members:—Henry Davey and Harry Robert Graham.

The special thanks of the Members were returned for the following donation to the fund for the promotion of experimental research :—Ludwig Mond, £100.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Pneumatics, including Acoustics and the Phenomena of Wind Currents. By Charles Tomlinson, F.R.S. London: Crosby Lockwood and Co. 1887. Fourth Edition.

The study of the atmosphere is one which must, from its very nature, be always carried on under circumstances different from those which attend research of any other kind. The atmosphere is invisible, it has no colour or smell. We can hardly say with reason that it affects our sense of touch, while a further disadvantage exists in the fact that we are unable to get out of it, and thus study it from the exterior. In all other branches of research we have to deal with substances or phenomena that we can either see, hear, weigh, or manipulate in some manner or another; but in this case we even go so far as to say that a vessel is empty if it contains nothing but air or any similar gas, showing that for long generations the atmosphere was popularly considered as nothing. Towards the close of the last century air was proved to consist of two gases possessed of distinct chemical properties, and from that time, we may say, nearly all our knowledge of its chemical, physical, and meteorological properties has been acquired. The most important instrument used in the study of pneumatics is the barometer, and in the book now before us we find its construction and use very completely described.

The height of the barometer is now intimately connected in our minds with the state of the weather, but many people fall into the error of thinking that a rise or fall indicates simply a wet or fine day, whereas it much more frequently points to the force and perhaps the direction of the wind; and even then we must often be in a state of uncertainty, as we can see from the discussion on the direction and causes of the trade winds, where Mr. Tomlinson tells us that in the West Indies they are inappreciable above the level of 3000 feet, and that a current in the opposite direction is met with at about 12,000 feet. An illustration of this is to be found in the volcanic eruption at St. Vincent in 1812, when the ashes were carried for a great distance in the opposite direction to the trade wind blowing at the sea level.

After devoting a good many pages to these and similar questions, we find the subject of vibrations of the air, or *acoustics*, briefly dealt with; while again, in the appendix, we come to a further study of the wind, with descriptions and illustrations of anemometers, and methods of using and applying them. In conclusion there is a short note on Sprengel's well-known air-pump, which has been, and is now, of such great value, not only in the laboratory but commercially, in the manufacture of incandescent lamps. The book is No. 12 of Weale's Rudimentary Series, and will no doubt be read with both profit and pleasure by those into whose hands it falls.

The Commonhealth. A Series of Essays on Health and Felicity for Everyday Readers. By B. W. Richardson, M.D., F.R.S. London: Longmans, Green, and Co. 1887.

The commonest question, one that is asked millions of times daily, is one that is answered incorrectly more often than any other. We refer to the everyday greeting, "How do you do?" So few people are, or ever have been, actually quite healthy, that their usual answer, "Quite well, thank you," is excusable on the ground that it is comparative. They are better than they were last week or yesterday. That really good health should be so rare to find is the greatest blot on our vaunted civilisation. Nearly all our habits, our dress, our food, and our manner of life tend to injure our health. In our earliest childhood we are accustomed to be insufficiently clothed, because it is said to look pretty to see a baby with short sleeves and bare legs and chest; we are often improperly fed, through ignorance; and not unfrequently subjected to severe frights and shocks to the nervous system, the effects of which can never be got rid of, through a mistaken idea of the way to correct or even amuse a child. The result of this early treatment is to be found in the death rate, which shows that a large proportion of deaths are those of children under four years. Modern medical science is doing all it can to save life and alleviate suffering, but does it cure disease? Those so-called noble institutions, our hospitals, keep alive and send out into the world thousands of persons who will marry though quite unfit, and thus contribute towards the deterioration of the race, while our healthiest men are continually being killed by accidents, by war, and by shipwreck. But do hospitals cure disease? We do not think so. This can hardly be put too strongly. Our modern system is based purely on individualism, while we totally ignore its probable effect on generations to follow. How can this be put right? It is to be done by paying more attention to our daily lives, by taking real care of our children, so that they may grow up really healthy and more fit to be the parents of the next generation. Whoever heard of a trainer of racehorses sending out a young horse in cold weather without proper covering to "harden it;" but this is done every day to thousands of human beings. Dr. Richardson's work on this matter is one of extreme importance. He points out numbers of little things to be done or left undone, of which every one will admit the truth.

Recreation is as necessary to health as food and clothing, but what is play for one would be hard work for another. To be really effective recreation must be a complete change, so that a new set of faculties is brought into use. When possible recreation and education should be combined, and severe strains on the mind, such as cramming for examinations, cannot be too strongly condemned. In the chapter on "Dress in Relation to Heath," Dr. Richardson gives a great deal of sound advice, and suggests modifications in clothing, especially in that of the gentler sex, which may easily be followed without any alteration in outward appearance, so that the charge of eccentricity cannot be urged as an excuse for their non-adoption. When we think of the modern style of female attire we cannot suppress the thought that it is a case of the survival of the unfittest. Pressure is exerted on nearly every part of the body which should be left free in its movements. The lungs and heart have often been displaced by tight-lacing, and varicose veins have often been brought on, or aggravated when already existing, by the use of garters. Male attire is much in advance of that of the other sex from a hygienic point of view; all parts of the body are equally covered, the waist is not used as a support for innumerable layers of clinging garments, which impede the free movements of the legs without really clothing them. We can even find good in the much abused "tall hat." When properly fitted it is not uncomfortable, and, moreover, it acts as a cooling chamber for the head, enclosing as it does a supply of air which can constantly be changed. Its principal fault lies in its colour—it should be grey instead of black. Do not let it be supposed from these remarks that Dr. Richardson advocates for ladies such an enormity as the divided skirt or any other quasi imitation of masculine attire; far from it. He would not have the outward style of female dress altered one bit, but simply some of the details and manners of wearing the different garments.

The latter part of the title is a well-chosen one. This

volume should indeed be in the hands of "everyday readers." In fact, if it were read in every school it could not fail to do great good in improving the welfare of the human race, which should be, if it is not always, the ultimate end of all scientific work.

A Manual of Weights and Measures, with Rules and Tables. By Oscar Oldberg. Second Edition. Chicago: Chas. J. Johnson. 1887.

A knowledge of figures, weights, and measures is one of the earliest and most important acquirements of the human race, and it is a curious fact that among civilised races the language of figures is practically universal. But with regard to weights and measures we are not so fortunate: with the exception of those countries which have adopted the metric system there are hardly two which agree even approximately. In a table showing this diversity we find that the weight of the pound in grammes varies in different countries from 500 to 214·25, with about twenty-five intermediate values. Again, even in England, some pounds are divided into 12 and others into 16 ounces; some ounces into 8 drachms, but one into 16, &c. Reform is certainly wanted, and many suggestions have been made; but we are afraid national pride has a great deal to do with the slow progress made in this direction. Mr. Oldberg lays great stress on the inconvenience arising from this want of uniformity, and enumerates the proposals which have from time to time been made to correct it.

As a book of reference this volume will be of very great service, containing as it does tables for the conversion of any unit into any other of the same class.

Journal of the College of Science, Imperial University, Japan. Vol. i., Parts 1 and 2. Published by the University, Tokyo. 1886 and 1887.

Up to the time of the issue of the first number of this Journal all memoirs and notes of work done in the University were published separately, but as some—though interesting in themselves—were not considered sufficiently important for separate publication, they were, so to speak, lost to science. As time went on it was found that more and more good work was being done, and it has at last been decided to publish this Journal regularly. This is a very important step for the Tokyo University to take, and one that will have the good wishes of all the scientific world.

The Journal is to be printed in English, French, or German, at the option of the writer of each article or communication.

The first paper in No. 1 is "On the Life History of *Ugimya sericaria*, Rond." This is a parasite which infests the silkworms in Japan, doing immense damage, sometimes as many as 70 or 80 per cent of the worms being attacked by it. The author of this paper has examined the subject in a most careful manner, and has prepared six excellent plates illustrating the various parts of the parasite and the phases of its development as seen through the microscope.

Then follows a paper on *Distoma endemicum*, a parasite which attacks the liver of the natives of Japan. Its life history has been studied with the same care as that of the other parasite just referred to.

Other notes—on earthquake diagrams obtained at Tokyo, on the deformation of metal plates in polishing, &c., &c.—complete the first part of vol. i.

The second part is devoted entirely to a long paper on the "Movements of the Earth's Atmosphere and Whirlwinds."

Annuaire pour l'Année 1887. Paris: G. Chamerot.

We have received the above-named pocket book from the Société d'Encouragement pour l'Industrie Nationale. It contains a calendar for the year and a list of the council and members up to date; also the names of the recipients of the Society's medals for last year. It is a handy little volume for those interested in the Society.

Short Report on the Activity of the Imperial and Royal Chemico-Physiological Experimental Station for the Cultivation of Wine and Fruits at Klosterneuberg, near Vienna, during the Years 1881-1885. (Kurzer Bericht über die Thätigkeit der K.K. Chemisch-Physiologischen Versuchsstation für Wein- und Obst-Bau zu Klosterneuburg bei Wien, während der Jahre 1881-1885.)

This institution has been by no means inactive; 2403 investigations have been carried on, involving 19,031 determinations. The substances examined besides wines have included brandy, rum, liqueurs, and fruit wines; vinegar, yeasts, argol, and tartrates; samples of sugar and glycerin, colouring and flavouring-matters used for wines, gelatin, isinglass, &c.; oils, waxes, and honey; waters, cattle-foods, manures, and industrial refuse, soils, rocks, and metals; samples of sumach, insecticides, &c. The authors remark that not a single case has occurred of an Austrian wine sold abroad having been found adulterated.

The effects of coal-tar products and salicylic acid added to wines have been studied, but the results are not here given.

The question of the addition to wines of starch-sugar—a more honest name than grape-sugar—has excited much attention. It is found that in the different samples of this sugar there are present from 13 to 17·5 per cent of matter incapable of fermentation, and in potato sugar syrups from 40 to 46 per cent. If it is permitted to add such sugars and syrups to must before fermentation, then the wines will contain a proportion of matter totally unlike anything occurring in natural wines, even if it should not be injurious to health.

It appears that bilberry wines are coming into use in Germany. They are prepared by adding a solution of sugar to the juice of the berries and allowing the liquid to ferment.

The use of foreign colouring-matters, especially of the injurious oxy-azo colours, is much more common in liqueurs than in wines.

As regards the food constituents of the vine, it appears that manganese must be regarded as essential. The yield of grapes from vines dressed with farm-yard manure was found lower almost by 50 per cent. than from those treated with potassium chloride and ammonium sulphate.

We are sorry to learn that the ravages of the phylloxera are still extending, and that the results of most of the proposed remedies are negative.

The olive trees of South Dalmatia are suffering both from fungi and from insects. It seems impossible to restrain the Dalmatian peasantry, and even the local authorities, from making war against insectivorous birds. The investigations carried on at Klosterneuburg and elsewhere prove how impotent man is against his worst enemies.

CORRESPONDENCE.

SOFTENING MAGNESIAN WATERS.

To the Editor of the Chemical News.

Sir,—Mr. Thomas T. P. Bruce Warren's letter is misleading. The point in dispute between Dr. Frankland, Sen., and myself is not whether — or how much — can Sudbrook water be softened by Clark's process. We agree that the initial hardness is about 28 degrees, and that by Clark's process the hardness may be brought down to 9½ degrees.

We differ as to the composition of the softened water. Dr. Frankland maintained that the magnesia remained almost intact. I, on the other hand, who have learned that solutions of magnesian salts are decomposed by lime-water so as to yield a precipitate of the almost absolutely insoluble hydrate of magnesia, maintained that the softened water must be almost devoid of magnesia.

I have verified my assertion by softening the Sudbrook water and then analysing the softened water. In one experiment I found 1·2 grains, and in another experiment 1·5 grains of magnesia in a gallon of Sudbrook water.

Mr. Warren has not ventured to deny the correctness of that result.

My conclusion, which will be shared by chemists, is that magnesian waters offer no special obstacles to Clark's process. That Clark's process only removes the lime in so far as the lime is present as carbonate, has not been in dispute. To me the Sudbrook water is interesting, as affording an excellent illustration of the correctness of the theory of softening, as set forth by me.—I am, &c.,

J. Alfred Wanklyn.

July 4, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 23, June 6, 1887.

Researches on the Density of Sulphurous Acid and of a Saturated Vapour.—L. Cailletet and E. Mathias.—The critical point of the sulphurous acid, the purity of which had been carefully ascertained, was + 156°, that is a little higher than +155·4°, as found by M. Sajotchewsky. The densities are represented graphically.

Combustion-Heats.—MM. Berthelot and Recoura.—In this paper the authors give the combustion-heats of glucose, quinone, naphthaline, benzoic and salicylic acids.

Combustion-Heats.—MM. Berthelot and Louguinine.—The determinations in the present paper refer to naphthaline, phenol, benzoic acid, cuminic acid, quinone, hydroquinone and pyrogallol.

Alteration-Products of Certain Alloys in Contact with Acids.—H. Debray.—Alloys of tin and of the platinum metals are attacked by hydrochloric acid. That of platinum and tin ($PtSn_4$) in contact with hydrochloric acid diluted with 10 vols. of water is slowly attacked, and, after contact for some days, is converted into blackish scales of the aspect of graphite. This transformation takes place instantaneously with concentrated acid, even in the cold, and with dilute acid in heat. The same products are obtained by attacking a regulus of tin containing platinum with strong or boiling hydrochloric acid. If the proportion of platinum forms one-fifth of the alloy concentrated hot acid must be used. Alloys containing rhodium, iridium, or ruthenium are less easily attacked by hydrochloric acid. It might seem that these graphite-like residues should contain merely the precious metal alone or alloyed with a proportion of tin. But all are found to contain a notable proportion of oxygen and of water. They behave like platinum black in a current of hydrogen, and they determine the explosion of detonating mixtures.

The Solubility of Copper Sulphate.—A. Etard.—The solubility of copper sulphate from − 2° to + 105° may be represented by two right lines which meet at or near 55°. At 103° to 105° the solubility undergoes a third modification. Between 105° and 190° the solubility decreases proportionately to the rise of temperature. The fact known concerning sodium sulphate is merely a particular case of a more general law. This fact seems connected with the bibasic function of acids.

Red Fluorescence of Chromiferous Gallium Oxide. Lecoq de Boisbaudran.—The red fluorescence given by chromiferous gallia in the vacuum tube has now been found to exhibit a very distinct linear ray; its position is $\lambda = 689{\cdot}7$ to $689{\cdot}8$.

Schweitzer's Liquid and Ammoniacal Solution of Copper.—H. Baubigny.—In order to prepare Schweitzer's reagent, the most rational method is to precipitate the solution of a copper salt with the theoretical quantity of soda, and to re-dissolve the hydroxide in ammonia.

On Cyano-Acetic Acid. — Louis Henry. — Cyano-acetic acid is easily split up, especially under the action of heat, into carbon-dioxide and acetonitrile. Its derivatives will probably behave in a similar manner. The acid may be obtained in well-defined crystals, perfectly white. This body does not melt at 55°, as it is asserted by M. Van t'Hoff, but at 65° to 66°.

Action of Ammonia upon Certain Chloro-derivatives of Ethane; Direct Fixation of the Elements of Ammonia upon Non-saturated Compounds.—M. Engel.—In this paper the author has studied the action of ammonia upon vinyle chloride, ethylene chloro-iodide, and chlorised ethylene chloride.

On Percolated Isoamyl-sebacic and Butyl-sebacic Ethers.— M. Gehring.— This paper is not adapted for useful abstraction.

On Cyanacetic Ether.—Alb. Haller.—The author has formerly announced that cyanacetic ether is able to exchange its hydrogen for sodium. To obtain this compound it is sufficient to treat a solution of the ether in absolute alcohol with the theoretical quantity of sodium alcoholate. The compound is white, almost insoluble in absolute alcohol, but soluble with decomposition in water. If exposed to the air it absorbs moisture and carbonic acid.

On the Ethyl Cyanoacetate of W. James.—Alb. Haller and Alfred Held.— The authors show that this compound, described in the *Journal of the Chemical Society* for April last (p. 287), is identical with the ethyl aceto-cyanacetate which they prepared five years ago (see *Comptes Rendus*, xcv., p. 235).

Determination of Starch in the Tubers of the Potato.—Aimé Girard.—The author places a known weight of rasped potatoes in contact, firstly with a weak solution of hydrochloric acid, to render the cellulose of the vegetable tissue easily attackable, then with a sufficiency of ammonio-cupric liquid to dissolve this cellulose, and to swell the starch. He then supersaturates with acetic acid and treats the mixture first with a normal and then with a decinormal solution of iodine in potassium iodide.

Organic Nitrogen in Compound Chemical Manures. — M. Gassaud. — The presence of leather waste in manures can be detected by means of the reactions of tannin. The author exhausted the sample with boiling water; he then made a similar decoction of leather and compared them with an aqueous solution of tannin. All three gave blue-black precipitates with ferric chloride, brown precipitates with potassium dichromate, and red precipitates with magenta. With ferrous acetate the decoctions of the manure gave a deep violet blue precipitate, and the solution of tannin a blue-black. Horn, blood, flesh, &c., gave nothing similar.

Journal de Pharmacie et de Chimie.
Series v., Vol. xv., No 8, April 15, 1887.

Action of the Fluorides upon Alumina.—MM. Fremy and Verneuil.—Alumina, without being in actual contact with calcium fluoride, but merely exposed to the emanations given off by this body, if ignited in the air, becomes mineralised, loses its amorphous condition, and is changed into a crystalline mass.

Characters of Debilitation undergone by Diastase under the Action of Heat.—E. Bourquelot.—Enfeebled diastase, even if used in excess, loses the power of pushing the degradation of starch to its utmost limit.

The Organisms producing the Decomposition of Urine.—M. Smith.—From the *British Medical Journal*.

Preservation of Yeast.—M. Boehm.—From the *Moniteur Scientifique*.

Detection of Traces of Chlorine.—M. Hager.—The reagent recommended is a solution of diphenylamine in strong sulphuric acid, which is poured gently down the side of the vessel containing the liquid under examination. If no blue colour appears, even after the lapse of some minutes, a fresh quantity of pure sulphuric acid is added. The presence of the least trace of chlorine is shown by a blue zone at the contact of the two liquids.

Bullelin de l'Association des Elèves de M. Fremy.
No. 8.

Preparation of Calcium Sulphide having a Violet Fluorescence.—A. Verneuil.—Already noticed.

New Process for the Chlorination of Carbides.—A. Colson.—A carbide is heated with a known weight of phosphorus pentachloride in a sealed tube to about 180°. The phosphorus chloride liberates a definite quantity of chlorine, which reacts upon the hydrocarbonic molecule.

Method for the Volumetric Determination of Sulphates.—H. Quantin.—Already noticed under the *Comptes Rendus*.

Practical Analysis of Coal-Gas as regards Ammonia, Hydrogen Sulphide, Carbon Dioxide, and Monoxide.—M. Chevalet.—The author describes here his process for the determination of ammonia.

New Processes for Preparing Crystalline Carbonates.—L. Bourgeois.—Already noticed.

MISCELLANEOUS.

International Review on the Adulteration of Food and Drink.—A new periodical is about to be published at Amsterdam under the above title. It will appear six times per annum, the first number on 15th July. The subject is an important one, and owing to its international character the new journal will doubtless be of service to the public health.

Lower Oxides of Molybdenum.—W. Muthmann.—The author has examined molybdenum dioxide, molybdenum dioxide molybdate, the action of reductive gases upon molybdic acid, and the intermediate oxides of molybdenum soluble in water. These include the blue oxide, Mo_3O_8, a definite compound and the olive-green oxide, which, if a definite body at all, seems too instable to admit of analysis. There is here, further, an account of the action of concentrated sulphuric acid upon metallic molybdenum, and of the combinations of molybdenum dioxide with bases. *Liebig's Annalen.*

Royal Dublin Society.—An adjourned general meeting of the Royal Dublin Society was held on Thursday, June 30th, for the purpose of confirming the new by-laws, and alterations in the old ones, rendered necessary by the resolution passed on March 3rd, to the effect that it is desirable that ladies be admitted as members of the Society. The great advances which have been made of late years in the higher education of women show that the fair sex are capable of doing excellent scientific work, and in such cases it is only just that they should be received as members of the societies to which they contribute the results of their researches. At the same time it will be as well not to be too ready in admitting all candidates, or there will be danger of converting what should be a scientific meeting into merely a social gathering.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Aluminate of Soda.—A correspondent ("W. C. L.") in your issue of July 1st asks for the address of a maker of aluminate of soda. Will you kindly give him ours?—Sullivan and Co., Lim., British Alkali Works, Widnes, Lancashire.

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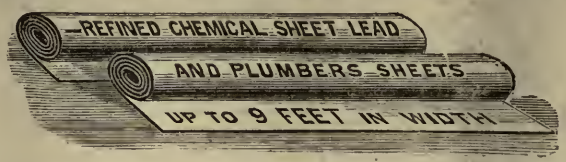

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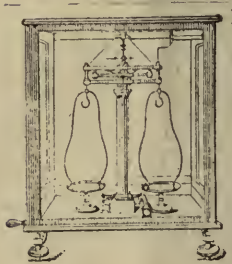

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July 8, 1887.

THE CHEMICAL NEWS.

Vol. LVI. No. 1442.

ON A NEW METHOD OF MEASURING MAGNETIC SUSCEPTIBILITY AND MAGNETIC PERMEABILITY.

By THOMAS T. P. BRUCE WARREN.

The following method of measuring magnetic forces opens up an important branch of chemical physics, and makes magnetism itself an interesting adjunct to analytical research.

Ordinary German silver, when tested with a magnet in the ordinary way, shows no attraction whatever, but if examined in this way is decidedly attracted by a magnet. It was, in fact, from examining the contacts of electrical apparatus, to determine what metal or alloy was used, that this method of procedure was developed.

A delicate chemical balance is placed on a firm table, and in the magnetic meridian. A weight of the substance whose susceptibility is required, either in powder or fine filings, is placed evenly on the pan of the balance, and equilibrium carefully made; a powerful horse-shoe magnet is then placed directly under the pan, which is prevented from approaching within a certain distance of the magnet. Care must be taken that, in every case, it should occupy the same position. Of course it would be more convenient to employ an electro-magnet, which could be fixed, and, after adjusting the weights, the magnet could be excited by contact with a battery. When a very intense magnetic field is required, a coil of wire connected with a dynamo is placed under the scale pan.

If we are operating on a paramagnetic or positive substance, the pan will be drawn down by the action of the magnet, and weights will have to be added to restore equilibrium. The weights required to restore equilibrium is a measure of the susceptibility of the substance in hand.

If, however, we are working with a diamagnetic or negative substance, we should expect the pan to be repelled. As these so-called substances are also attracted, we are driven to the conclusion that diamagnetism as opposed to paramagnetism, in its general acceptation, has no existence; still, although a substance may have its poles, relatively to an exciting magnet, as implied by these prefixes, no case of magnetic repulsion has yet been met with.

A carefully balanced platinum crucible was found to be strongly attracted. Bismuth was decidedly attracted, but behaved with a curious sluggishness, which was very much reduced by diminishing the distance. Metallic manganese, although not affected by a magnet in the ordinary way, has a decided influence by this method of testing.

It is preferable in some cases to attach a powerful magnet to one of the ends of the beam, in place of the scale pan, as we are then independent of the magnetic influence due to the metal of the pan, and, having once balanced the magnet, we obviate the necessity of having to weigh each substance operated on.

We are indebted to Sir William Thomson for the terms magnetic "susceptibility" and magnetic "permeability," and it is in precisely the same sense as used by him that those terms are employed in this paper; thus "susceptibility" implies that condition which ordinarily is understood of becoming magnetic, and "permeability" may be taken as meaning the power of conversely arresting the transmission of magnetic energy, or a kind of porosity.

In addition to these terms we frequently use the expressions "retentive power" and "residual magnetism." These terms express what is practically the extremes of the same idea. Many substances are magnets when under the influence of another magnet, but as independent magnets return almost to their zero condition. The power of retaining magnetic polarity, *per se*, deserves a scientific recognition. It has now become a recognised fact that the retentive power of steel can be increased by the addition of other metals; although, themselves feebly magnetic, it is generally considered that their influence is due to tempering or hardening iron.

Residual magnetism may be roughly measured by noting first the force which draws the magnet to the substance experimented on, and, after magnetising by any of the ordinary methods, replace the same, and note the alteration in the attractive force. The same method may be used for measuring the rate of acquiring, under a constant magnetic force, the maximum of induced or permanent magnetism.

In experimenting on the magnetic permeability of substances the arrangement of the magnet or magnetic field is the same as in the previous case: a plate of the metal or stratum of liquid is inserted between the magnet and some iron filings or magnet.

When the plate is removed the magnet is attracted to within a fixed distance of the filings, the weight required to produce equilibrium is noted; the plate is then inserted, and the diminished attraction again noted. The difference in weight is due to the arrest of magnetic influence by the interposed layer.

The effect produced by differences in thickness of the interposed layer does not appear to follow the law of variation for magnetic attraction as generally accepted.

The magnetic permeability is known to be a function of susceptibility. A class of substances appear to exist which are almost magnetic insulators, but as a rule the higher the susceptibility of a substance is, the greater will be its permeability: this we might have expected.

This method of experimenting on magnetic permeability leads to the conclusion that we are not warranted in treating a vacuum as magnetic; on the contrary we have, simply by exhaustion, altered the permeability of an interposed layer of air. When a magnetic substance is made to approach a balanced magnet, the force of attraction was as follows:—

At 41·0	m.m.	distance	0·026 grm.
,, 20·5	,,	,,	0·520 ,,
,, 14·0	,,	,,	1·300 ,,

so that at one-third the distance, in this experiment, the attraction is fifty times as great.

The magnetic force is no doubt increased, partly by the diminished distance, and partly by increasing the permeability of the intervening layer of air in consequence of reducing the thickness of the stratum.

In order to obtain comparative results the unit weight is less reliable than the unit volume. It seems to me that the unit adopted must, in the case of a substance of definite chemical nature, be a function of its molecular weight.

I am working on this matter with a view of ascertaining the magnetic equivalents of substances,—that is, the weights of substances required to produce the unit force, at the unit distance, in the unit field.

A curious result of this enquiry is, that in delicate chemical operations where weighing magnetic substances is concerned, we cannot disregard the intensity and horizontal force in the place where our weighings are made.

Action of Crystalline Acetic Acid upon Lævo-Rotatory Camphene.—J. Lafont.—The action of acetic acid upon lævo-rotatory camphene only gives rise to a single acetate, which is dextro-rotatory, and which, on saponification with alcoholic potassa, yields merely camphenol and acetic acid.—*Comptes Rendus*, Vol. civ., No. 24.

STUDY ON THE REACTIONS OF THE VANADATES FROM AN ANALYTICAL POINT OF VIEW.

By A. CARNOT.

The author has previously shown that vanadic acid forms with barium a salt insoluble in water containing ammonium chloride and very little free ammonia, and that under the same conditions the salts of strontium give no precipitate, a characteristic which may be utilised either for the determination of vanadic acid or for the separation of barium and strontium.

Lime and Magnesia.—The salts of lime and those of magnesia behave like those of strontium, and yield no precipitate in dilute solutions. The case is different with the phosphoric and arsenic acids. In strong and highly ammoniacal solutions there is formed a partial deposit of vanadate, which renders the separation of these acids by means of magnesium salts inaccurate.

Alumina.—On neutralising an acid solution containing vanadic acid and alumina, the latter in precipitation carries down with it vanadic acid. They cannot be completely separated even on repeating the operation many times. Nor can we succeed by precipitating the alumina in a slightly acetic solution, nor by employing ammonium hydrosulphate. The presence of traces of vanadium is always shown by the brownish colouration which the alumina takes on contact with ammonium hydrosulphate.

Chromium.—Chromium sesquioxide likewise fixes the vanadic acid, and may even retain it entirely, if in sufficient quantity, on precipitation either with ammonia or with ammonium hydrosulphate.

Uranium : Determination as Vanadate.—Uranium salts precipitate vanadic acid entirely, not merely when the liquid is ammoniacal, but also in presence of a slight proportion of free acetic acid, as occurs on precipitating the phosphoric and arsenic acids. This reaction may be utilised for the determination of vanadic acid.

We neutralise the acid solution almost completely with ammonia; we add a few grammes of ammonium acetate, and a sufficiency of uranium nitrate, and raise to a boil. Then is formed a yellow precipitate resembling arsenic sulphide in colour.

We ascertain that the reagent is in excess by taking up a drop of the liquid with a glass rod and letting it fall upon a plate in contact with a drop of potassium ferrocyanide. This drop ought to be tinged brown by the uranium salt, if any of it remains in solution. The precipitate is received upon a filter, washed with pure water, dried, and separated from the filter, which is burnt separately. The precipitate, on ignition to redness, loses water and ammonia, taking a pale yellow colour. It contains then 24·22 of vanadic acid. This determination succeeds not only in presence of the alkalies and alkaline earths, but also with most of the metallic oxides. It is especially suitable for isolating vanadic acid from the oxides of manganese, zinc, and copper, which accompany it in certain natural vanadiates.

But the uranium salt cannot serve for separating vanadic acid from phosphoric and arsenic acids, often found in the same ores, because they are entirely precipitated,—nor from molybdic and tungstic acids, which are at least partially precipitated by the same reagent.

Iron.—Vanadic acid is partially carried down in the precipitation of ferric oxide, but it is not as difficult to separate from this base as from alumina or chrome. We can succeed by means of ammonia or ammonium acetate or hydrosulphate, repeating the operation several times.

Manganese : Determination as Vanadate.—Manganese oxide forms with vanadic acid a definite and insoluble compound, which mny be usefully employed in the determination of vanadium.

The vanadic solution is mixed with ammonium chloride and ammonia in slight excess, and heated to a boil. There is then poured in manganese sulphate or chloride mixed with sal-ammoniac, and the whole is boiled for two or three minutes. The flask is removed from the fire (giving off a slightly ammoniacal odour); it is plunged into cold water, and allowed to stand until clear. It is then filtered, and washed with cold water. The precipitate is a yellowish brown divanadate. It should not contain brown particles. On ignition it passes to a reddish brown, and contains 56·25 per cent of vanadic acid.

Vanadic acid cannot be separated in this manner from phosphoric or arsenic acid, as they are both entirely precipitated under the same conditions. They might, in certain cases, be determined by the same method.

Tungstic acid is also, in part, precipitated on boiling with a salt of manganese.

Molybdic acid, on the contrary, remains entirely in the ammoniacal solution, especially if the ebullition is not kept up too long. It may then be determined by precipitating the manganese by ammonium hydrosulphate, and, lastly, molybdenum sulphide by hydrochloric acid. The separation of vanadium and molybdenum is thus effected with great exactness.

The precipitation of vanadic acid by a salt of manganese is a convenient means for its extraction from alkaline or ammoniacal solutions. It must be precipitated either in heat or in the cold as manganese vanadate; then ignited with sulphur or in a slow current of hydrogen sulphide, and finally treated with hydrochloric acid diluted with 15 or 20 vols. of water. The manganese sulphide is easily dissolved, while the vanadium sulphide remains untouched.—*Comptes Rendus*, Vol. civ., p. 1844.

CONTRIBUTIONS TO OUR KNOWLEDGE OF ANTIMONY PERCHLORIDE.*

By RICHARD ANSCHÜTZ and P. NORMAN EVANS.

(Concluded from p. 2).

The Reaction of Antimony Pentachloride and Oxalic Acid.

As has already† been remarked, our research on the chlorides of antimony sprung originally from the wish to find out if the reaction of anhydrous oxalic acid and antimony pentachloride was analogous to that of phosphorus pentachloride, forming an antimony oxychloride, $SbOCl_3$, corresponding to the oxychloride of phosphorus. The knowledge of the action of water on antimony pentachloride, forming mono- and tetra-hydrates, increased the interest in the attempt to discover the action of oxalic acid on the same body.

On mixing equal molecular weights of pure anhydrous oxalic acid and antimony pentachloride, a violet development of hydrochloric acid takes place, the mixture forming a nearly solid white mass. The generation of hydrochloric acid soon ceases. On heating to about 150° decomposition begins again, carbonic dioxide and hydrochloric acid being given off, the mass becoming gradually liquid. This clearly showed that the reaction ran in two stages. In the case of the monohydrate we had obtained our object so quickly by the use of chloroform, that we did not pursue the direct action of antimony pentachloride on oxalic acid further, but substituted a cooled solution of 35·5 grms. of antimony pentachloride in 83·3 grms. of chloroform, with 10·6 grms. of anhydrous oxalic acid. The reaction commenced in the cold; at first hydrochloric acid mixed with a small quantity of carbon dioxide was given off, but soon only hydrochloric acid; gradually a considerable amount of a white crystalline body fell out of solution. After the development of hydrochloric acid had ceased, we heated the product of the reaction, dissolving the greater part of the crystals. We filtered hot, and

* A Paper read before the Royal Society, June 16, 1887.

† *Chem. Soc. Journ.*, vol. xlix., p. 708.

beautiful transparent colourless crystals separated from the filtrate, which we had placed in a desiccator over sulphuric acid and paraffin. The residue, insoluble in the hot chloroform solution, weighed 4·9 grms., and consisted chiefly of unaltered oxalic acid. The quantity of hydrochloric acid collected was 4·7 grms., while 8·5 grms. should have been found had the reaction taken place according to the equation—

$$(COOH)_2 + SbCl_5 = SbCl_3O + CO_2 + CO + 2HCl.$$

This reaction was, however, impossible, owing to the small quantity of carbon dioxide given off. The quantity of hydrochloric acid found indicated that two molecules of antimony pentachloride had reacted with one of oxalic acid. The tabular crystals from the chloroform solution melted at from 148·5° to 149°, decomposing at a somewhat higher temperature. The values found by analysis corresponded to the formula $Sb_2Cl_8C_2O_4$.

	Grm. substance.		
1.	0·4680	gave 0·2637	Sb_2S_3.
2.	0·2647	,, 0·1421	Sb_2S_3.
3.	0·1444	,, 0·2670	AgCl.
4.	0·2261	,, 0·4174	AgCl.
5.	0·8117	,, 0·1950	$C_2O_4Ca + H_2O$.
6.	0·2522	,, 0·0589	$C_2O_4Ca + H_2O$.
7.	0·2956	,, 0·0415 CO_2 and 0·0160 H_2O	Combustion with lead chromate.
8.	0·8777	,, 0·1162 CO_2 and 0·0162 H_2O	

As a result of these simple experiments we can understand the entirely different behaviour of antimony and phosphorus pentachlorides towards the carbon compounds containing oxygen and hydrogen. Antimony pentachloride unites, as we have proved, with water. Phosphorus pentachloride decomposes water. Antimony pentachloride has no inclination to change chlorine for oxygen. Phosphorus has this inclination in an extraordinary degree. Phosphorus pentachloride attacks hydroxyl or ketone groups, replacing oxygen by respectively one or two atoms of chlorine, being itself converted into oxychloride. Antimony pentachloride, on the other hand, reacts on the hydrocarbon residue, substituting chlorine for hydrogen, and itself becoming antimony trichloride.

Phosphorus pentachloride acts similarly to antimony pentachloride, substituting chlorine for hydrogen in those organic compounds which contain no oxygen, or oxygen in such firm combination with carbon as not to be available for the formation of phosphorus oxychloride.

Antimony pentachloride may react as phosphorus pentachloride on compounds similar to oxalic acid, containing no hydrogen attached to carbon which can be replaced by chlorine. The compound $(COOSbCl_4)_2$ is of especial theoretical interest, as showing the process of the reaction of phosphorus pentachloride on substances containing the hydroxyl group. The first stage of the reaction consists, evidently, of the formation of compounds analogous in composition to the body $(COOSbCl_4)_2$.

If, however, the oxygen of a hydroxyl group is held in loose combination, the formation of phosphorus oxychloride and the substitution of chlorine take place simultaneously. What, however, will happen when the substitution of oxygen is difficult, as in phenol or the aromatic oxyacids? Attempts to answer this question are now in progress in the laboratory of the Chemical Institute of the University of Bonn, and we anticipate that the result will be the preparation of bodies having the general formula $R'OPCl_4$.

	Calculated for $Sb_2Cl_8C_2O_4$.	Found.							
		1.	2.	3.	4.	5.	6.	7.	8.
Sb	39·61	38·93	38·52	—	—	—	—	—	—
Cl	46·10	—	—	45·74	45·64	—	—	—	—
C	3·89	—	—	—	—	—	—	3·83	3·61
C_2O_4	14·28	—	—	—	—	14·47	14·07	—	—
H	—	—	—	—	—	—	—	0·59	0·20

The compound, $Sb_2Cl_8C_2O_4$, is formed according to the equation—

$$(COOH)_2 + 2SbCl_5 = C_2O_4Sb_2Cl_8 + 2HCl.$$

Proceeding exactly as described above, but taking one molecule of oxalic acid to two of antimony pentachloride, *i.e.*, twice the quantity, almost the entire product is soluble in chloroform.

37·2 grms. $SbCl_5$ dissolved in 55 grms. $CHCl_3$ and
5·5 grms. $(COOH)_2$ gave
4·3 grms. of HCl, the calculated quantity being
4·8 grms.

It is necessary to have a good return-flow condenser in order to avoid a considerable quantity of chloroform distilling into the weighed water, used for collecting the hydrochloric acid. On mixing $Sb_2Cl_8C_2O_4$ with warm water, it is decomposed, setting oxalic acid free. This may be easily determined after removing the antimony from the acid solution. The following constitutional formula seems most simply to explain the formation and decomposition of this new compound:—

I. $\begin{matrix} COOSbCl_4 \\ | \\ COOSbCl_4 \end{matrix}$,

oxalic acid in which the hydrogen atoms are replaced by the univalent radical $Sb'Cl_4$. Considering the fact that the compound does not unite with a second molecule of oxalic acid, the formula—

II. $\begin{matrix} COO \\ | \\ COO \end{matrix}\!\!>\!SbCl_3SbCl_5$

does not seem at all probable. According to formula I. one can compare the compound with diammonium oxalate, and designate it as ditetrachlorstibonium oxalate, or, as we prefer, look on it as the mixed anhydride of oxalic acid and the yet unknown acid, $SbCl_4OH$.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, June 16th, 1887.

Mr. William Crookes, F.R.S., President, in the Chair

Mr. William Henry Coates was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. George Carrington, B.A., Missenden Abbey, Great Missenden, Bucks; Yoshimosa Koga, Imperial Mint, Osaka, Japan; William Henry Richardson, Dudley; Arthur Walley Warrington, Dinglefield, Dingle Lane, Liverpool.

The following were elected Fellows of the Society:—Messrs Hugh Barclay, William Bott, L. C. Daniell, Ernest Francis Ehrhardt, William Nathaniel Evans, Frederick William Freeman, Edward Day Gravill, Herbert James Gover, John Edward Green, Richard Nelson Jones, M.R.C.S., Khasberas B. Jodhara, J. M. Kavanagh, William Marshall, Henry Hewetson McMinnes, Fred. Lawrence Overend, B.A., J. Stanley Phillips, John T.

Sheard, Walter Shelley Spencer, Charles Ernest Stedman, Henry Livingstone Sulman, Frank Traphagen, Ph.D., Frederick Percy Watson, John William Young, B.A.

The President announced that the following Address had been presented to Her Majesty :—

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

On the happy completion of the fiftieth year of your Most Gracious Majesty's reign we, the President, Council, and Fellows of the Chemical Society, established in 1841 and incorporated under a Charter granted in the 12th year of your Majesty's reign, desire to present to your Majesty our sincere congratulations, and to express our loyal devotion to your August Person and to your Throne.

We humbly submit, amidst the general rejoicing, that we have special reason to rejoice in the growth of Science, and particularly of Chemical Science, which characterises your Majesty's wise and beneficent reign. It it be borne in mind to what an extent the applications of Chemistry are now essential to the prosperity and the security of your Majesty's Empire, this development assumes a truly national importance.

Chemistry is of no nationality, yet the names of Black, Cavendish, Dalton, Davy, Faraday, and Graham fully testify to the vigour of its growth on British soil. From a variety of causes, however, its cultivation in this country during the second quarter of the century seemed to be falling into neglect, and it is to His Royal Highness the late Prince Consort that the nation is very largely indebted for its revival.

The turning-point in the history of Chemical Science in your Majesty's Dominions was the foundation of the Royal College of Chemistry in the year 1845. To the success of this College the Prince Consort contributed, not merely by his personal munificence and by consenting to become its first President, but more particularly by using his influence to overcome the obstacles in the way of the appointment of its first Professor.

The result cannot be exaggerated; indeed, a majority of British Chemists of the younger generation are directly or indirectly the pupils of that College, while the discoveries in Chemical Science of its Students may well rank amongst the most brilliant achievements of your Majesty's reign.

If Chemical Science in this country is no longer ignored, but is recognised as essential to national prosperity, if Chemistry has won its rightful place in the curriculum of the higher education, and if laboratories properly organised for the conduct of this intellectual discipline are to be found in British Universities, Colleges, and Schools, these happy changes are mainly due to the exertions and influence of the late Prince Consort and to the impulse given by the Royal College of Chemistry in response to his encouragement. The Prince Consort's enlightened zeal in the furtherance and development of Science in the country of his adoption is universally recognised, and we rejoice to find that his Royal Highness the Prince of Wales treads in the footsteps of his illustrious father.

It is our most earnest prayer that your Most Gracious Majesty may long be spared to reign over a happy, loyal, prosperous, and united empire, and that your Majesty's enlightened and beneficent example may steadily be followed and held in grateful remembrance.

We remain, with profund respect,

YOUR MAJESTY'S MOST FAITHFUL SERVANTS.

The following papers were read :—

59. "*A Study of the Thermal Properties of the Mixture of Ethyl Alcohol and Ethyl Oxide.* By WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.

The authors have previously shown that for both the gaseous and the liquid states, the relation of pressures to temperatures at constant volume may in the case of methyl and ethyl alcohols, ethyl oxide and carbon dioxide, and presumably in the case of all stable liquids, be expressed by the formula $p = bt - a$; *i.e.*, the isochoric lines, or lines of equal volume, for unit mass of the substance, are straight when mapped against pressures as ordinates and temperatures as abscissæ. They also showed that in the case of the two dissociating substances, acetic acid and nitric peroxide, such isochoric lines are not straight, but are, at large volumes, tangential to the theoretical isochoric lines of minimum density at higher temperatures, and at lower temperatures probably tangential to the theoretical isochoric lines of maximum density. A comparison of the behaviour of such stable and dissociable substances has shown the effect of chemical union on the relations of pressure, temperature, and volume. But the mixture of two liquids, such as alcohol and water, is known frequently to be accompanied by contraction and by evolution of heat. It therefore appeared of interest to thoroughly investigate the behaviour of such a mixture in order to throw light on the nature of this attraction.

Experiments were therefore made with a view to determining the relations of volume, pressure, and temperature between wide limits with a mixture of alcohol and ether, of which, individually, the constants have already been obtained.

The most striking conclusions are (1) the dependence of pressure during condensation on volume, so that the vapour-pressures are represented not by a line but by a band; (2) the curvature of the isochoric lines at temperatures and pressures near the condensing points of the mixture; (3) the great alteration of volume under certain conditions on mixing the two bodies, amounting, on the one hand, in some circumstances to a contraction of 4 per cent, and in others to an expansion of 115 per cent.

DISCUSSION.

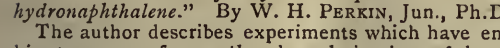
Prof. DEWAR said that, in dealing with the historical part of the subject, the authors of the paper had in his opinion omitted to do full justice to the work of Amagat and other investigators. A short time ago Messrs. Ramsay and Young had communicated a paper to the Royal Society, entitled "A Preliminary Note on the Continuity of the Liquid and Gaseous States of Matter," which had been referred to that evening, purporting to contain a discovery which was nothing more than a simple elementary deduction from Van der Waals' formulæ representing the continuity of the gaseous and liquid states of matter. The Van der Waals' formula had been improved upon by Clausius; in its original form, however, it was still sufficient to account for Andrew's isothermal law and Amagat's law of the limiting volume of a gas under high pressure,—two of the most important experimental deductions from a vast number of observations. Prof. Amagat in continuing his work had discarded all antecedent theoretical views, and had confined his attention to the approximate laws he could deduce from the experimental facts. He had long ago given the equation that Messrs. Ramsay and Young evidently thought important enough to embody in the form of a paper. In dealing with this subject the mass of calculations made by the authors may satisfy some views, but real progress in this department of physico-chemical inquiry can only be made by reaching greater accuracy in the measurements, always assuming that the substances examined are pure. Endless repetitions of details can only cumber the ground, not clear it.

The experiments on the critical volume of PH_4Cl, to which Dr. Young referred, were in reality made by a pupil of the speaker (Mr. Skinner), and had already been published.

Dr. YOUNG, in reply, said that the work of Amagat and others was referred to in the paper, but owing to the short time at his disposal he had been unable to do full justice to the history of the subject that evening. Although Van der Waals' formula could be converted into theirs, the converse was not the case; moreover, Van der Waals' formula did not represent the facts.

60. "*Derivatives of Hydrindonaphthene and Tetrahydronaphthalene.*" By W. H. Perkin, Jun., Ph.D.

The author describes experiments which have enabled him to prepare from *ortho*xylene derivatives of the closed chain hydrocarbons—



Hydrindonaphthene. Tetrahydronaphthalene.

Hydrindonaphthenedicarboxylic acid was obtained from the ethylic salt formed by the action of the dibromide, $C_6H_4(CH_2Br)_2$—prepared by heating orthoxylene with bromine at 125°—on the disodium-derivative of ethylic malonate, $CNa_2(COOEt)_2$: when heated at 200° this acid is resolved into carbon dioxide and hydrindonaphthenecarboxylic acid.

Tetrahydronaphthalene-derivatives were obtained in two ways: (1) by the action of orthoxylylene dibromide on the disodium-derivative of ethylic acetylenetetracarboxylate,—

$$\begin{matrix} CNa(COOEt)_2 \\ \vdots \\ CNa(COOEt)_2 \end{matrix},$$

and (2) as the end result of the following series of changes:—Ethylic sodiomonochloromalonate,—

$$CNaCl(COOEt)_2,$$

having been submitted to the action of orthoxylylene dibromide; the resulting compound,—

$$C_6H_4[CH_2{\cdot}CCl(COOEt)_2],$$

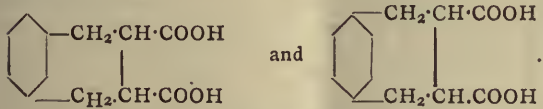
was digested with zinc-dust and acetic acid, and the chlorine having been displaced by hydrogen, the product was converted into the disodium-derivative,—

$$C_6H_4\begin{cases} CH_2{\cdot}CNa{\cdot}(COOEt)_2 \\ CH_2{\cdot}CNa{\cdot}(COOEt)_2 \end{cases},$$

which on treatment with iodine gave the theoretical amount of tetrahydronaphthalenetetracarboxylate. On heating the tetracarboxylic acid at 200° it is resolved into CO_2, water, and the anhydride of tetrahydronaphthalenedicarboxylic acid; on dry distillation of the silver salt of this latter acid, naphthalene is produced, together with the anhydride of tetrahydronaphthalenedicarboxylic acid, silver, CO_2, and water.

61. "*The Synthetical Formation of Closed Carbon Chains in the Aromatic Series.*" By F. S. Kipping, B.Sc., Ph.D.

The author describes experiments which were instituted with the object of ascertaining whether it would be possible, by substituting meta- and para-xylene for orthoxylene, to obtain isomeric tetrahydronaphthalene derivaof the formulæ—



The method of procedure was the same as that described in the previous paper. Meta- and para-xylylene dibromides were each treated with ethylic sodiochloromalonate, the product was reduced with zinc-dust and acetic acid, and the reduction product was converted into the sodium-derivative, which was treated with bromine.

The reaction appeared to take place with perfect regularity, sodium bromide separating; but on examination it was found that the greater part of the product consisted of the unchanged substance, and no new closed chain compound could be detected. It is difficult to understand what really takes place in these reactions, or what the precise action of the bromine on the sodium compound is.

Discussion.

Dr. Miller thought that since the authors had not yet proved even the possible existence of rings consisting of 7 and 8 carbon atoms, the experiments quoted by them could not be considered as proof that ring-formation from two side-chains attached to a benzene nucleus depends solely on *position*. The chain of 6 carbon atoms in the ortho-compound,

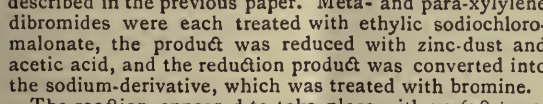
$$C_6H_4\begin{matrix} CH_2{\cdot}CNa(COOEt)_2 \\ CH_2{\cdot}CNa(COOEt)_2 \end{matrix},$$

might be expected to yield a ring composed of 6 carbon atoms, because such rings are not only possible but possess very great stability. There is, however, nothing surprising in the fact that the chains of 7 and 8 carbon atoms in the corresponding meta- and para-compounds do not yield corresponding rings, especially when considered in conjunction with Dr. Perkin's other unsuccessful attempt to produce a ring containing 7 atoms of carbon. The well-known property possessed by so many ortho-derivatives of readily yielding anhydro- and other ring-derivatives is without doubt a function of the 1 : 2 position, but whether this is so in the case of the above-mentioned compound cannot be regarded as proved. Indeed it is conceivable that the length of the side-chains may be an important factor in determining the condensation. It would be interesting to ascertain whether an *ortho*-derivative of similar constitution to the above, but containing an additional atom of carbon in each side-chain, would also yield a ring-derivative; if not, it would be an argument that ring formation depends on *length* of chain as well as position.

Dr. Kipping said, in reply, that he had anticipated the objection raised to the theoretical conclusions he had deduced from his experiments. He had, therefore, tried a number of experiments on the action of metaxylylene bromide on the sodium-derivative of ethylic malonate. If a reaction analogous to that which resulted in the formation of hydrindonaphthene-derivatives from orthoxylylene bromide were to take place, a compound should have been formed containing a ring consisting of *six* carbon atoms, in which, however, the junction was effected to carbon atoms in the meta-position. In no case, however, could such a substance be obtained. It therefore appeared to him that the main reason why ring-formation did not take place, when meta- and para-derivatives of benzene were used, was that the side-chains were not in a suitable position.

62. "*The Product of the Action of Ethylene Bromide on Ethylic Acetosodacetate.*" By P. C. Freer, Ph.D., and W. H. Perkin, Jun., Ph.D.

The compound formerly described by W. H. Perkin, Jun., as ethylic acetyltetramethylenecarboxylate having been proved to contain a carbon-oxygen-ring, being an anhydride of a carboxylate of acetobutylic alcohol, it was thought advisable to examine the product of the action of ethylene bromide on ethylic acetosodacetate, in order to finally settle the nature of the compound known as ethylic acetyltrimethylene carboxylate. Ethylene bromide interacts with ethylic acetosodacetate, forming a compound, $C_8H_{12}O_3$, to which the following formulæ are applicable:—



That the first is inapplicable has been shown in a previous publication: further experiments show that the product is to be regarded as a mixture of the compounds represented by the latter two formulæ. That this is the case is proved by the decomposition of the acid obtained from the ethereal salt; if this be distilled CO_2 is given off, and an oil passes over, separable into two substances, one boiling at 112°, which is insoluble in water, even after standing for weeks; the other boiling 20° lower, which gradually dissolves in water, forming acetopropylic alcohol. It is therefore safe to regard the ethereal salt,

$C_8H_{12}O_3$, as a mixture of ethylic acetyltrimethylene-carboxylate with a compound which it is proposed to call ethylic *methyldehydropentonecarboxylate*.

The acids obtained on hydrolysing the ethereal salt just referred to are decomposed on boiling with water into CO_2 and acetopropylic alcohol. This reaction is in entire accordance with the character of the trimethylene-ring, as shown in the change of trimethylenedicarboxylate into carbobutyrolactone.

The ether $C_8H_{12}O_3$ readily combines with hydrogen bromide, forming ethylic ω-bromethyl acetoacetate, a change which is likewise in accordance with the behaviour of the other trimethylene compounds.

If this latter compound be boiled for some hours with dilute muriatic acid, it is quantitatively converted into alcohol, CO_2, HBr, and acetopropylic alcohol. Acetopropylic alcohol is easily reduced by sodium amalgam, being converted into γ-pentylene glycol.

63. "*Derivatives of Pentamethylene.*" By H. G. COLMAN, B.Sc., and W. H. PERKIN, Jun., Ph.D.

δ-Pentylene glycol, $CH_3{\cdot}CH{\cdot}(OH){\cdot}CH_2{\cdot}CH_2{\cdot}CH_2(OH)$, is converted by the action of HBr into the corresponding γ-pentylene dibromide, $CH_3{\cdot}CHBr{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Br$.

When this bromide is mixed with ethylic sodiomalonate in alcoholic solution the following reaction takes place :—

$$2CHNa(CO_2Et)_2 + CH_3{\cdot}CHBr{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Br = CH_2\begin{<}CH_2{\cdot}CH{\cdot}CH_3 \\ CH_2{\cdot}C(CO_2Et)_2\end{>} + CH_2\begin{<}CO_2Et \\ CO_2Et\end{>} + 2NaBr.$$

Ethylic methylpentamethylenedicarboxylate is a pleasant smelling oil, b.-p. 243° to 244°. The corresponding acid is crystalline, and melts at 173° to 175°, decomposing into CO_2, and methylpentamethylenemonocarboxylic acid. The latter is a colourless liquid which boils at 220°; it possesses a penetrating smell similar to that of butyric acid.

64. "*The Synthesis of Hexamethylene-derivatives.*" By P. C. FREER, Ph.D., and W. H. PERKIN, Jun., Ph.D.

Hitherto all attempts to synthesise hexamethylene-derivatives have been unsuccessful, owing to the impossibility of obtaining a pentamethylene dibromide of the formula $CH_2Br{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CHBr$, which could be submitted to the action of ethylic sodiomalonate. The authors have, however, succeeded in preparing a homologue of the desired bromide from acetobutylic alcohol, $Ac{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2OH$. This alcohol is readily reduced to δ-hexylene glycol by means of sodium amalgam, as Lipp has shown. This glycol is completely converted by treatment with hydrogen bromide into δ-hexylene dibromide, $CH_3{\cdot}CHBr{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Br$, which interacts with ethylic sodiomalonate, forming ethylic methylhexamethylenedicarboxylate,—

$$CH_3{\cdot}CH{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}C(COOEt)_2.$$

65. "*An Attempt to Synthesise Heptamethylene-derivatives.*" By P. C. FREER, Ph.D., and W. H. PERKIN, Jun., Ph.D.

If δ-hexylene dibromide, $CH_3{\cdot}CHBr{\cdot}(CH_2)_3{\cdot}CH_2Br$, be treated with two molecular proportions of ethylic sodiomalonate, the tetracarboxylate,—

$$(COOEt)_2CH{\cdot}CH(CH_3){\cdot}(CH_2)_4{\cdot}CH(COOEt)_2,$$

is produced. It appeared probable that if the disodium-derivative of this compound were treated with bromine a closed chain heptamethylene-derivative would result. This, however, was found not to be the case, the action taking place in some other manner not yet made out.

DISCUSSION.

Dr. ARMSTRONG said that the problem which Dr. Perkin and his associates were endeavouring to solve was one of great theoretical importance. In representing the compounds which had been described as derivatives of closed-chain hydrocarbons, they were undoubtedly formulating what would appear to be the simplest interpretation of the synthetical methods adopted; but there was little independent conclusive evidence to support their view. In several respects the behaviour of the compounds was by no means that of closed-chain derivatives; thus it was remarkable that the trimethylene-ring should be easily split by hydrogen bromide and by water, but not by bromine. If, however, a closed carbon chain could be split by such means, the conditions realised in the case of the trimethylene-compound described by Freer and Perkin were certainly those which would tend most to favour such a change. In illustration of the difficulty of determining whether a compound was saturated, the speaker referred to xeronic acid, which Fittig had represented as the derivative of a closed chain of 4 carbon atoms, but which has recently been proved to be a diethylfumaric acid. Assuming that the compounds described were closed-chain derivatives, the failure to obtain a hepta-methylene-derivative gave weight to Dr. Miller's objection to Dr. Kipping's argument, and justified the conclusion that the number of carbon atoms as well as position had to be taken into account.

Dr. JAPP referred to the hydrocarbon prepared by Burton and himself from anhydracetonebenzil (*Chem. Soc. Trans.*, 1887, 423): it is highly probable that this is a tetra- or penta-methylene-derivative, and it is noteworthy that it does not undergo any change if heated with iodhydric acid and phosphorus at 150°.

66. "*The Composition of Shale-Spirit.*" By A. K. MILLER, Ph.D., and T. BAKER, B.Sc.

The authors have sought to determine (*a*) whether shale-spirit contains any higher olefines than those found in the liquid mixture of hydrocarbons from oil-gas, and (*b*) the constitution of the olefines, Armstrong and Miller having shown that heptylene was the highest hydrocarbon of the C_nH_{2n} series present in oil-gas products, and that all the olefines from oil-gas possess a normal constitution.

The shale-spirit was fractionally distilled, and the three fractions boiling respectively at 140° to 145°, 120° to 125°, and 75° to 85°, were examined by the method described by Armstrong and Miller (*Chem. Soc. Trans.*, 1886, 74). Each fraction was found to consist of paraffin to the extent of about 50 per cent, the remainder being partly olefine and partly less unsaturated hydrocarbons of unknown constitution. The bromine addition-compounds of the latter are to a large extent decomposed by distillation in a current of steam, yielding tarry products, whilst the olefine bromides distil over unchanged. After distilling the bromides under reduced pressure, the olefines were recovered by the zinc-copper couple; they were then fractioned; and finally the fatty acids produced by their oxidation with potassium permanganate were examined.

The results obtained show that not only the lower olefines, but also octylene and nonylene are present in shale-spirit. The nonylene was readily obtained in a state of comparative purity, and its oxidation-products indicated it to be the pure normal olefine, heptylethylene. The lower olefines were, however, more difficult to purify, and gave a more complex mixture of oxidation-products. The octylene fraction (b.-p. 120° to 122°), for instance, gave both heptylic and caproic acids (the latter in larger quantity), together with acetic and formic acids; and in the same way the hexylene fraction (65° to 70°) was found to yield more butyric than valeric acid, these being also accompanied by formic and acetic acids. In the same way as the production of heptylic and formic acids indicates the presence of normal octylene, the formation of caproic and acetic acids might be regarded as evidence that an isomeric octylene is also present; but this is not necessarily the case, as acetic acid appears to be a constant product of the oxidation of normal olefines, so that no definite conclusion can be drawn from its presence, especially as it is produced to a relatively small extent;

in fact, the authors consider that the caproic acid probably owes its origin to the presence of heptylene in the octylene, the separation of the lower olefines by fractional distillation being accomplished with difficulty unless very large quantities of material are dealt with.

It is noteworthy that, whereas in the manufacture of oil gas the paraffins are all but destroyed and no olefine higher than heptylene is obtained, shale-spirit, which is produced by the decomposition of paraffins at a much lower temperature, is rich in paraffins and higher olefines.

67. "*The Magnetic Rotatory Power of the Ethyl Salts of Maleic and Citraconic Acids and their Isomers.*" By W. H. PERKIN, Ph.D., F.R.S.

The result of the examination of the ethylic salts of maleic, citraconic, and itaconic acids show that in the magnetic field they affect polarised light like most substances of the kind differing by 2H from normal saturated compounds.

The author has already shown (*Chem. Soc. Trans.*, 1884, 561) that such unsaturated compounds have a greater molecular rotatory power than saturated compounds to the extent of a little more or less than 1·0; thus, the value for allyl is about 0·914 higher than that of propyl, and the value for oleic compounds is about 1·112 higher than that for corresponding saturated compounds. In the case of the acids under consideration the increase is a little higher still, as the following comparisons show:—

Ethylic maleate ..	9·647	Ethylic itaconate ..	10·630
„ succinate ..	8·380	„ methylsuccinate ..	9·347
Difference ..	1·267	Difference ..	1·283

Ethylic citraconate	10·499
„ methylsuccinate	9·347
Difference	1·152

The small difference between the molecular rotatory power of the itaconic and citraconic salts is undoubtedly due to the structure of the compounds being somewhat dissimilar.

The fumaric and mesaconic compounds afford very considerably higher values, thus:—

Ethylic fumarate ..	10·119	Ethylic mesaconate	11·269
„ succinate ..	8·380	„ methylsuccinate ..	9·347
Difference ..	1·739	Difference ..	1·922

From these results, maleic, citraconic, and itaconic acids may be regarded as ordinary unsaturated compounds related to succinic and methylsuccinic in a similar way that α-crotonic and oleic acids are related to butyric and stearic acids. Fumaric and mesaconic acids belong to a different class of compounds. The interpretation to be given to the very high molecular rotatory powers of these compounds is not at present evident. The results of this investigation do not appear, however, to be in favour of the formulæ lately suggested by Anschütz to explain the somerism of maleic and fumaric acids.

68. "*The Temperatures at which various Sulphates undergo Decomposition.*" By G. H. BAILEY, D.Sc., The Owens College.

On account of the use which is frequently made of sulphates in atomic weight determinations, it is important to ascertain to what temperature they can be heated without undergoing decomposition, as it is necessary to apply heat in order to dehydrate and expel adherent acid. The author heats the sulphate containing excess of acid, in the apparatus which he had previously described, at a known temperature—say 360°—till of constant weight; the temperature is then raised, and the heating continued, &c. For a considerable range of temperature the weight remains constant, but a point is ultimately reached at which further loss of weight occurs, indicating that the temperature has been reached at which the normal sulphate decomposes.

Zinc sulphate begins to decompose at 410°, bismuth sulphate at 405°; lead, magnesium and sodium sulphates are stable up to 500° at least. The behaviour of didymium sulphate is quite different from that of the other salts, and the limits of temperature within which it is stable are not sharply defined.

69. "*The Reaction between Sulphites and Nitrites of Metals other than Potassium.*" By EDWARD DIVERS, M.D., F.R.S., and TAMEMASA HAGA, F.C.S.

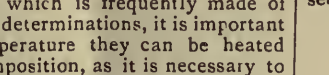
Referring to a recent paper by Raschig (*Ber.*, 1887, 584), the authors state that they have for a long time been aware that hydroxylamine is producible from various nitrites by the action of sulphurous acid and sulphites, and have only delayed making this known that they might at the same time communicate the results of their examination of the stages of the reaction when sodium salts are used. Fremy entirely failed to prepare sodium salts corresponding with the potassium compounds he has described. The authors, however, have succeeded in preparing sodium salts which are unmistakably compounds of the simpler acids of which Fremy prepared potassium salts.

On mixing solutions of sodium sulphite and nitrite slight heat is developed (when metasulphite is substituted the rise in temperature is more marked), and the mixture increases in alkalinity; when two formula weights of sulphite to one of nitrate are taken, all sulphite and nitrite as nearly as possible, cease to exist as such, in about ten day's time. For some time after mixing sulphite can be precipitated as barium salt, nitrite being left in solution; but when the interaction is complete, the barium precipitate is that of a hydroxylaminesulphonate free from sulphite and sulphate (traces excepted), and the mother-liquor contains a barium aminesulphonate and very little hydroxylaminesulphonate. On dissolving the barium precipitate in acid, no evidence of the presence of hydroxylamine is obtained until the liquid has been heated: a precipitate of barium sulphate is then produced, much hydroxylamine being then formed. The barium precipitate is probably the slightly soluble salt of hydroxylaminedisulphonic acid, and the soluble barium salt, that of aminetrisulphonic acid, which on heating becomes di- and mono-sulphonic acids, sulphuric acid separating.

By acidifying and heating a mixture of sodium sulphite and nitrite in suitable proportions, the authors have obtained almost all the nitrogen of the nitrate as hydroxylammonium sulphate. Metasulphite appears to be still better suited than the normal sulphite for the preparation of hydroxylamine.

70. "*The Action of Acetyl Chloride on Acetoximes.*" By VICTOR MEYER and A. W. WARINGTON, B.Sc.

The authors find that if the acetoxime obtained from isopropylketone and hydroxylamine be treated with acetyl chloride at a low temperature, the corresponding acetate is formed; but that if the temperature be allowed to rise the product is an isomer of the acetoxime. This isomer is a solid, and crystallises in colourless needles; it melts at 102°, and boils at 210°. On hydrolysis it yields isobutyric acid and isopropylamine, and it may be prepared from isobutyric chloride and isopropylamine: an isomeric change therefore takes place, the nature of which may be seen on comparison of the formulæ:—



Diisopropylacetoxime. Isopropylisobutyramide.

No such isomeric change occurs on similarly treating dipropylacetoxime, the corresponding acetate being the only product.

71. "*Sulphinic Compounds of Carbamide and Thio-carbamide.*" By GEORGE MCGOWAN.

The compounds described are:—

(1.) $(CSN_2H_4)_2 \cdot (Cl_3CSO_2)_2$ = dithiocarbamide ditrichloromethylsulphinate.

(2.) $CSN_2H_4 \cdot Cl_3CSO_2H$ = thiocarbamide trichloromethylsulphinate.

(3.) $CON_2H_4 \cdot Cl_3CSO_2H$ = carbamide trichloromethylsulphinate.

(4.) $CSN_2H_3 \cdot Cl_3CSO_2$ (?) = trichloromethylsulphinylthiocarbamide.

The first of these is prepared from ammonium trichloromethylsulphinate and dithiocarbamide dichloride; the second by dissolving equimolecular proportions of thiocarbamide and ammonium trichloromethylsulphinate in alcohol, and adding a slight excess of a concentrated solution of hydrogen chloride; the third is prepared in the same way as the second, avoiding water, which decomposes it, the fourth is obtained together with dithiocarbamide dichloride by the action of trichloromethylsulphonic chloride on thiocarbamide.

72. "*Anacardic Acid.*" By Dr. S. RUHEMANN and S. SKINNER, B.A.

Anacardic acid was originally obtained by Staedler from the oil contained in the shell of the fruit of *Anacardium occidentale;* he assigned to it the formula $C_{44}H_{32}O_7$ (C = 6). The authors find that it is an hydroxycarbolic acid of the formula $C_{22}H_{32}O_3$. They describe several salts, and give the results of their analyses.

NOTICES OF BOOKS.

Notes and Formulæ for Mining Students. By J. H. MERIVALE, M.A. London: Crosby Lockwood and Co.

This work addresses itself mainly to the student of coal-mining. The author begins his introduction with the statement:—I am frequently asked by students to advise them as to the course of study they should pursue in order to pass the Colliery Manager's examination," and he remarks with the utmost justice that "the successful English mining engineer of the future will have to be (as his continental rival long has been) not only a good practical man, but a man of science as well."

As a matter of course very much of the instruction here given will be available for students who look forward to a position in other departments of mining, such, *e.g.*, as the sections on strength of materials, on timber, explosives, machinery, prime movers, boilers, the transmission of power, &c. For this last purpose Mr. Merivale speaks in favour of compressed air, as the most handy form of transmission for mining purposes, having the collateral advantages of improving the ventilation and cooling the mine. He does not think that in mines where the maximum distance is only about three miles, electricity is likely to compete successfully either with air or with wire ropes, though it will be available for the transmission of power to very great distances. The author is in favour of electric lighting below ground as far as stationary lights are concerned. The portable electric lamps for miners hitherto constructed are too costly and too heavy. He considers that there is no danger from shocks if a continuous current of not more than 200 volts or an alternating current of not more than 75 volts is used. He points out, however, that there is a risk of sparks firing gas at the commutator or at the two ends of a broken wire.

The cost of sinking and fitting up a shaft will somewhat astonish the general reader. If there is but little water it is given as £50 per fathom for 100 fathoms. If there is a good deal of water the cost may be doubled.

On the other hand, the London public who are compelled to pay 20s. per ton and upwards for coal may be edified to learn that the total cost of coal, delivered into waggons at the pit, including labour underground and on the surface, rent, rates, fuel, agency, depreciation, and interest, is only about 5s. per ton "under ordinary conditions of trade," so that there is an exceedingly large margin left for carriage and for profit!

We scarcely feel satisfied with a table given of the estimated extent of the principal coal-fields of the world. That of China is given as only about one-tenth that of the United States, though we have heard it estimated as equal to if not exceeding the latter in extent. Nor is there any mention of the South African field (Natal and the Orange Free State) which is considered as more extensive than that of Great Britain. But here, as well as in China, much remains to be done before the boundaries of the coal-areas are accurately mapped out.

Mr. Merivale may justly congratulate himself on having produced an exceedingly useful manual.

Revista Pharmaceutica do Instituto Pharmaceutico do Rio de Janeiro. Nos. 7, 8, and 9.

A pharmaceutical journal, written, of course, in the Portuguese language. The most important matter contained is a series of articles entitled "Pharmaceutical Studies of the Plants of the Brazilian Flora," which, doubtless, is far from having been as yet thoroughly explored.

CORRESPONDENCE.

SOFTENING MAGNESIAN WATERS.

To the Editor of the Chemical News.

SIR,—Mr. Wanklyn says, in his letter which appeared in the last issue of the CHEMICAL NEWS (vol. lvi., p. 11), that "my conclusion, which will be shared by chemists, is that magnesian waters offer no special obstacles to Clark's process."

I wish simply to say that this is not my conviction, and that in fact I know, *personally*, of cases in which the Clark process has had to be abandoned.

If lime-water be added in large excess, the hydrate of magnesium which is thrown down clogs the filters so badly that the water ceases to pass through after two hours' use.

If, instead of using clear lime-water, we use a slightly milky lime-water, a larger quantity is thrown down, and the precipitate is granular and allows filtration to go on better; but even in this case the improvement has been so slight that the partial removal of magnesian salts has not justified its adoption.

I do not deny the correctness of Mr. Wanklyn's results in the analyses of the softened water referred to. I suppose, if anyone took the trouble to operate on a highly-charged magnesian water, the removal of magnesia might be carried to the extent Mr. Wanklyn mentions.

We require a proof of its feasibility when operating on an ordinary water supply.—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove, Forest Gate.

Simultaneous Precipitation of Mixtures of Iodates and Sulphates of Barium Salts.—M. Chroustchoff.—On precipitating a mixture of potassium iodate and sulphate dissolved in water, by the solution of a barium salt equivalent in quantity to one of the two potassium salts, we obtain precipitates very valuable in composition. The distribution of the base between the two acids seems at first an irregular and very complex phenomenon, but on attacking it analytically and colorimetrically we recognise the different phases, successive and simultaneous, of the precipitation of mixtures.—*Comptes Rendus*, civ., No. 24.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 24, June 13, 1887.

On the Earthy Phosphates; Remarks on a Communication by M. Joly.—M. Berthelot.—The experiments of M. Joly, read in the present session, supply novel and interesting data for our knowledge of the earthy phosphates. The author had previously established the existence of two distinct states of the (alkaline) earthy phosphates, a colloidal and a crystalline, the latter corresponding to a greater liberation of heat. Among the crystalline phosphates, M. Joly distinguishes the simple and the double phosphates.

Note on the Residues resulting from the Action of Acids upon the Alloys of the Platinum Metals.—H. Debray.—The author has previously shown that three cases are here possible. We may either obtain the platinum metal in a crystalline state, or a well-defined alloy or residues containing a noteworthy proportion of water and of oxygen, and even of nitrogen if the acid employed has been the nitric. The first case occurs with osmium alloyed with zinc or tin, and with ruthenium and iridium alloyed with lead. The action of hydrochloric acid upon zinc and tin (or that of nitric acid upon lead) is much facilitated by the presence of the platinum metals. The phenomenon is the same when the precious metal, in place of simply dissolving in the tin, &c., forms with it a compound less readily attacked than the tin itself. If there has taken place a combination of the precious metal and of the common metal, attended by a lively disengagement of heat, there is formed, under the influence of the special currents set up in the acid liquid, a complex body containing oxygen, nitrogen, and water.

Fluorescences of Manganese and Bismuth.—Lecoq de Boisbaudran.—This paper does not admit of useful abridgment.

Variations of the Absorption Spectra of the Compounds of Didymium.—Henri Becquerel.—In recent communications the author has shown that the principal directions of absorption of certain bands observed through crystalline compounds of didymium, enable us to recognise in these crystals, by means of their optical properties, a mixture of different substances. Further, that on dissolving these crystals in water the unequal displacements or the disappearance of the same bands show that a certain number of these substances are compounds unequally affected or even destroyed by water. As among these optically different bodies we find all those which chemical analysis has hitherto enabled us to isolate, we must ask if all are distinct simple bodies, or if, for the most part, they are multiple salts or sub-salts of a more restricted number of simple bodies at different degrees of oxidation? This latter hypothesis is the one to which we are led by the experiments described below. It is interesting to remark that the absorption spectra of dilute solutions of various compounds of didymium, sulphates, nitrates, chloride, platino-cyanide, differ very little from each other, whilst the absorption-spectra of these same compounds when crystalline are respectively very different. When by means of graduated ignitions we expel progressively first the water, then a part and finally the whole of the acid of one and the same salt of didymium, we obtain different products, some transparent and some pulverulent and opaque, but whose absorption spectra can yet be observed by reflection. We see, then, in each of these products, different absorption bands appearing and disappearing. The author then gives a very extensive table of the approximate value of the mean wave-lengths of the principal bands of the absorption spectra thus obtained. When didymium nitrate has undergone igneous fusion, it still shows most of the bands observed in crystalline compounds. If the ignition is continued, keeping the temperature below dull redness, it loses a part of its nitric acid and is transformed into a white powder, slightly rose-coloured or yellowish. This substance, which gives the characteristic spectrum indicated above, seems to be a basic nitrate. By ignition at a higher temperature it continues to lose nitric acid. On igniting this sub-nitrate in a current of pure dry hydrogen, and raising the temperature from cherry-red to an orange-red we obtain products which give a series of different spectra. It is interesting to mention that in the spectra obtained by the successive transformations of one and the same compound series of bands, seem to be transferred bodily from one spectrum to another, so that the variation of the number of luminous vibrations, or of the inverses of the wave-lengths of the corresponding bands, is a number approximately constant for each series. Each spectrum presents several of these series with different constants. The characteristic bands of several of these compounds coincide with the variable bands of the spectra of the crystals. The series of sulphates gives results of the same order as the series of the nitrates.

Researches on the Tri-Metallic Phosphates.—A. Joly.—The author has studied the tribasic phosphates of strontium, calcium, and barium.

Metallic Vanadates.—A. Ditte.—An account of the vanadates of magnesium, barium, calcium, nickel, cobalt, zinc, copper, lead, silver, and cadmium.

Hydrochlorates of Chlorides: Ferric Chloride Hydrochlorate.—M. Engel.—The author has formerly shown that hydrochloric acid precipitates chlorides from solution, 1 mol. of hydrochloric acid displacing approximately 1 mol. of chloride. There are, however, exceptions to this law. The author has prepared two definite hydrochlorates of zinc chloride and a stannous chloride hydrochlorate. Hydrochloric acid does not precipitate the solution, however concentrated, of ferric chloride. Dry hydrochloric acid liquefies the two hydrates $Fe_2Cl_6+12H_2O$ and $Fe_2Cl_6+5H_2O$.

The Influence of Heat and Light upon Chlorination.—Henri Gautier.—This investigation refers to chloro-substitution in compounds belonging to the aromatic series. M. Schramm has recently taken up the study of halogenous substitutions in the hydrocarbons; he finds that not only heat intervenes to determine the formation of such or such an isomer, but that even at 0° substitution products can be obtained in the chains on operating in solar light. M. Gautier therefore has examined if these rules, founded upon observations relating only to the hydrocarbons, are applicable also to substances of a different chemical function, and he has chosen for his experiments an acetone methylbenzoyl. He finds that whatever may be the temperature prevailing substitution always takes place in the chain, and, contrary to what takes place in the hydrocarbons, light has no influence on the nature of the reaction, affecting merely its speed. M. Gautier therefore asks if the presence of an electro-negative group in the aromatic nucleus prevents an element of the same nature from being substituted for the hydrogen; if this substitution could not be effected in presence of aluminium chloride; if the reaction would be wanting among compounds of analogous structure, but containing hydrogen only in the nucleus, such as benzoyl chloride, benzophenone, &c.

On Sebacedinitranilide.—G. Gehring.—Sebacedinitranilide crystallises from water in fine needles; from ether in large prisms with a square base, melting at 116°, and capable of sublimation. It is white, very sweet, but does not reduce cupro-potassium tartrate.

On Certain Derivatives of Inosite.—M. Maquenne.—Inosite is a hexatomic alcohol, of a simple function,

derived from hexamethylene. It ought to be regarded as a mannite with a closed chain, and not as a polyphenol.

On Pterocarpine and Homopterocarpine, two Crystalline Principles obtained from Red Santal-wood.—MM. Cazeneuve and Hugounenq.—From the wood of red santal (*Pterocarpus Santalinus*) there have been already isolated santaline, the colouring-matter and a crystalline compound, santal, isomeric with piperonal. Pterocarpine is a white crystalline body, insoluble in water and in cold alcohol, slightly soluble in boiling alcohol and in ether. It dissolves in chloroform, from which it separates in splendid clinorhombic prisms. It softens and melts at 152°, taking a yellow colour. This compound is insoluble in acids and potassa lye even at a boil. Homopterocarpine is a white crystalline substance, soluble in ether, chloroform, benzene, and carbon disulphide. From ether it crystallises in fine needles.

A Compound of Chromic Acid with Aniline.—Ch. Girard and L. L'Hote.—An aniline chromate can be prepared only by the double decomposition of an alkaline bichromate and aniline hydrochlorate, both solutions as cold as possible. The compound is sparingly soluble in cold water, and is decomposed by boiling water. If moist it is attacked by air and light, but when dry it is permanent. If treated with hot water it produces various colouring-matters, similar to Perkin's mauveine.

The Composition of Butters of Different Origins.—E. Duclaux.—The author questions the constancy of the proportion of volatile fats in genuine butters. He finds that the sum of the butyric and caproic acids ranges from 7·95 to 5·77 per cent. The greatest uniformity is found in the butters of Isigny. In this district there is the greatest uniformity in the race and in the conditions of alimentation. M. Duclaux thinks that, in addition to the care employed in making and preserving the butter, the race of the cows and the food supplied, the geological nature of the soil, and the climate, are not without influence.

On Fermentations caused by the Protoplasm of an Animal recently Killed.—M. Fokker.—This paper deals with the question of heterogenesis.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 7, April 5, 1887.

Latent Heats of Dissociation.—H. Le Chatelier.—Already noticed.

On Active Camphene and Borneol Ethylate.—G. Bouchardat and J. Lafont.—Not adapted for useful abstraction.

On a Tannin contained in the Berries of the Mountain Ash.—C. Vincent and M. Delachanal.—The juice of ripe mountain-ash berries contains, besides sorbine and glucose, an astringent principle, having a very acid reaction. Caustic alkalies and ammonia turn it an intense gold-yellow, which disappears on acidification. It does not precipitate solutions of alum; it reduces salts of silver in heat, precipitates copper acetate of an olive-green, turns a very intense dark green with ferric salts, which the alkalies and ammonia alter to a reddish brown. With neutral lead acetate it gives a light yellow precipitate; with the sub-acetate a very pure lemon-yellow. It does not precipitate gelatin. On distillation it gives a thick brown liquid, rich in pyrocatechine, and leaves a voluminous charcoal. This tannin approximates closely to morintannic acid, and especially to caffeotannic acid, but differs from them in several respects. The authors propose to name it sorbitannic acid.

Water of Crystallisation of Alums.—P. de Boissieu.—An examination of the results of M. Maumené. The author maintains that under ordinary conditions alum crystallises with 24 mols. of water, and not with 29. He does not regard the existence of a lower hydrate as probable.

Action of Sulphuric Acid upon the Solubility of Sulphates.—R. Engel.—Already noticed.

An Organic Acid obtained by the Action of Alcoholic Potassa upon a Mixture of Chloroform and of Acetone.—R. Engel.—The author has obtained an acid, $C_{11}H_{20}O_6$, and has examined its lead and zinc salts.

Analysis of Coffees.—L. Padé.—The author points out two novel frauds in the coffee trade. Raw coffee which has been sea-dipped is washed, decolourised with lime-water, washed anew, dried rapidly, and coloured either by a slight roasting or by dyeing with azo-oranges. By such manipulations green Santos coffees are made to pass as Java growths, worth about 25 per cent more. Dealers have lately conceived the idea of restoring to coffees the 17 to 19 per cent of weight which they lose in roasting. This is done by exposing the roasted beans to steam, and coating them with glycerin, palm oil, or even vaseline (!), to prevent evaporation. Beans so manipulated, instead of being hard and brittle, become elastic and horny under the teeth.

Vol. xlvii., No. 8, April 20, 1887.

Presence of Levo-Rotatory β-Oxybutyric Acid in the Blood of a Diabetic Patient.—L. Hugounenq.—Külz, Minkowski, and Stadelmann have observed the presence of a large proportion of levo-rotatory β-oxybutyric acid in the urine of certain diabetic subjects. The author has had the opportunity of verifying this observation as far as urine is concerned, and of further ascertaining that the blood of such a subject contained also a considerable quantity of this acid.

Qualitative Detection of Sulphites in presence of Hyposulphites and Sulphates.—A. Villiers.—This paper has been noticed under the *Comptes Rendus*, in which it appeared almost simultaneously.

Researches on Barium Phosphates: Application to Acidimetric Analysis.—A. Villiers.

Researches on Roussan's Process for the Treatment of "Phlegms."—M. l'Abbé L. Godefroy.—The author considers Roussan's process as simple, inexpensive, and deserving the attention of chemists and industrialists.

On Fluorescent Matters.—Lecoq de Boisbaudran.—The author considers that manganese compounds do not exalt or strengthen a pre-existing power of fluorescence, but produce it where it had no previous existence.

MISCELLANEOUS.

The Æolus Waterspray General Ventilating and Electrical Engineering Company.—On Monday and Tuesday last the Æolus Waterspray Co. gave an interesting exhibition of the action of their patent ventilators, at their premises in High Holborn. This system of ventilation was patented several years ago, and is now becoming widely known and appreciated throughout the country. The method employed for inducing a current of air is, as its name implies, by a spray of water squirting through a nozzle of peculiar construction, so arranged that it can be flushed in a few moments whenever necessary, simply by giving a few turns to a screw. The action of this spray is somewhat similar to that of a Bunsen filter-pump or a Giffard injector, the rush of water dragging the air after it. One gallon of water is said to be sufficient to move 1000 cubic feet of air, which is much more than could be done if the power used was applied to driving a fan for the same purpose. Besides ventilating apparatus, this company supply all kinds of electrical machinery and appliances for electric lighting. Their mechanical or acoustic telephone is by far the simplest and most effective telephone for short distances, such as a mile or so; it is free from all patents, does not require an electric battery to work it, and is very cheap, three points in its favour which should strongly recommend it.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chemical Manures.— Wanted the titles of any good *practical* books on chemical manure making.—SUPERPHOSPHATE.

Agricultural Chemistry.—I am leaving this country in two or three weeks for Fiji, in the capacity of chemist to a sugar estate there. 1st. Can any private individual purchase or procure copies of reports of experiments made on the sugar-cane as to its yield of sugar under different manurial, &c., treatment? 2nd. Could you name any good works on Agricultural Chemistry in the German language, few being in our English? I am of course acquainted with Ville's "Artificial Manures." 3rd. Where or how could I procure a Chamberland filter, which is seemingly the best? My purpose being to attempt the purification of the drinking water, which you will know is credited or rather blamed for causing dysentery.—ROBERT DAVIDSON.

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Notice to Contributors of Memoirs.—Authors are reminded that, under an arrangement dating from 1871, the acceptance of Memoirs, and the days on which they are to be read, are now as far as possible determined by Organising Committees for the several Sections before the beginning of the Meeting. It has therefore become necessary, in order to give an opportunity to the Committees of doing justice to the several Communications, that each Author should prepare an Abstract of his Memoir, of a length suitable for insertion in the published Transactions of the Association, and the Council request that he will send it, together with the original Memoir, by book-post, on or before August 3rd, addressed thus:—"General Secretaries, British Association, 22, Albemarle Street, London, W. For Section ——." Authors who comply with this request, and whose Papers are accepted, will be furnished before the Meeting with printed copies of their Reports or Abstracts. If it should be inconvenient to the Author that his Paper should be read on any particular days, he is requested to send information thereof to the Secretaries in a separate note.

Reports on the Progress of Science, and of Researches intrusted to individuals or Committees, must be forwarded to the Secretaries, for presentation to the Organising Committees, accompanied by a statement whether the Author will be present at the Annual Meeting.

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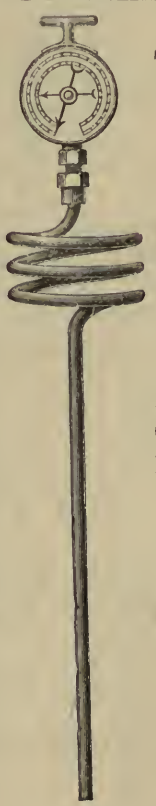

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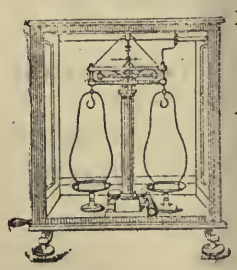

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THE CHEMICAL NEWS.

Vol. LVI. No. 1443.

ON METALLIC MANGANESE.

By THOMAS T. P. BRUCE WARREN.

A short time ago I had occasion to examine a specimen of commercial metallic manganese. I found that it was not visibly affected by a powerful compound horse-shoe magnet. I then carefully rubbed some to a very fine powder in an agate mortar, as I had reason to suspect the presence of particles of iron when powdered in a steel mortar.

A little of the powder was sprinkled on a thin sheet of well-glazed paper, placed over the same magnet. When the paper was gently drawn laterally or lengthwise to the direction of the poles, a few particles were seen to be strongly drawn out from the rest, whilst the greater portion seemed unaffected; this was evidently not due to mere differences of inertia in the particles.

A steel pen nib was then strongly magnetised, and the point drawn through the powder; the attracted particles gathered in small tufts and behaved as though they were capable of faintly attracting other particles.

It seemed to me an interesting matter to endeavour to account for this unexpected result. Reference to "Watts's Dictionary" (art. "Manganese") strengthened my perplexity.

Manganese made by Brunner's method is said to be non-magnetic, and as this statement occurs in "Watts's Dictionary" with the editorial query, my curiosity was, so far, at least pardonable.

Ten grms. of the metal were dissolved in dilute hydrochloric acid with a piece of platinum foil thrown in, so as to expedite the solution. A residue amounting to about 12 per cent was left undissolved, consisting apparently of silica, carbon, and fluor-spar; the whole was transferred to a porcelain dish, so as to burn off the carbon, when a copious inflammable vapour was given off, burning with a strong smoky flame.

The presence of this inflammable vapour may admit of explanation in this way, that the oxide, flux, and reducing materials were heated in the vapour of light petroleum so as to avoid the ingress of atmospheric oxygen; or, as Deville has pointed out, it may arise from the rock oil adhering to the sodium, which is used by Brunner in its preparation from the chloride.

"The metal obtained from the chloride or fluoride by Brunner's process has also the aspect of cast-iron, and is very brittle, but it is not magnetic. (What power was used in testing it?)"*

As Sir William Thomson has recently pointed out that petroleum is capable of affecting a magnet, I thought that the presence of this vapour might have something to do with its magnetic indifference. The powdered metal was carefully heated for some hours over a gas blower in a piece of combustion tubing, through which a current of hydrogen was passed, and the metal allowed to cool in a current of the same gas. A slight increase in weight was observed, and the portion of the tube near the porcelain boat was dimmed by the action of fluorine or a volatile fluoride, but no condensed petroleum was collected, although the smell was distinctly perceptible.

I must remark, however, that this result of heating is unsatisfactory, and showed that a little air must have crept into the tube. The experiment should be repeated with the necessary precautions to guard against the intrusion of air or moisture. This heating did not produce any marked change in its magnetic behaviour.

The hydrogen which was given off when the metal was dissolved in hydrochloric acid gave a peculiar smell, which at the time was attributed to electrolytic hydrogen. I have reason, now, for believing that the smell was due to the evolution of a carbide of hydrogen.

Since putting these notes together, I have examined this manganese by the method given in the Chemical News (vol. lvi., p. 15), and I find that it is distinctly magnetic, although decidedly low. I cannot say, from experience, whether it is abnormal in this respect to manganese prepared by any other process. I have always been under the impression that manganese is but feebly magnetic.

The chemical treatment of this subject has lead to the important conclusion that, knowing the susceptibilities of two or more materials, we can calculate what may be expected when they are mixed together.

Manganese, chromium, cerium, titanium, and osmium are placed by Faraday in the magnetic class, because certain of their compounds exhibit the ordinary magnetic relations.

When we consider that with a delicate balance we can detect a force amounting only to 1-500th grain, we must admit we have at once a simple and delicate method of measuring magnetic forces. A balance turning with 1-100th grain, or even more, will be delicate enough for most purposes.

EXPERIMENTS ON THE VOLUMETRIC ESTIMATION OF COBALT IN PRESENCE OF NICKEL.

By NORMAN McCULLOCH.

While engaged in examining a new process for volumetrically estimating manganese,—a method founded on the precipitation of the manganese in presence of peroxide of hydrogen with caustic soda, boiling off excess of hydroxyl, and subsequent treatment with standard ferrous salt,—I had occasion to observe that the principle of the process might be applicable to the determination of cobalt in presence of nickel, the former metal precipitating apparently as the sesquioxide, the latter as the green hydrated protoxide; and, accordingly, the composition and constancy of the cobaltic hydroxide so precipitated I proceeded to carefully investigate.

But the reliability of the process to exactly determine manganese I found, as the test of repeated experiment, to be unsatisfactory. The results varied nearly 3 per cent from the mean, and the fact was revealed that hydrated binoxide of manganese in reaction with peroxide of hydrogen undergoes partial reduction, and approximates in composition to the formula Mn_7O_{13}.

An experience practically analogous awaited my efforts to found a volumetric analysis of cobalt on the principle above alluded to. Almost every conceivable mode of application failed to eliminate a variation of nearly 2 per cent from the mean of its indications, and a cobalt oxide in presence of hydrogen peroxide is oxidised, or reduced, as the case may be, to an oxide of probably complex constitution, and representable by the empirical formula $Co_{13}O_{19}$.

Another fairly promising field of inquiry suggested in the treatment of the cobalt in ammoniacal solution with peroxide of hydrogen, and subsequent estimation of the oxygen taken up. The solution, saturated with ammonium chloride and strongly alkaline, was treated with the oxidant, and decomposition of excess of same assisted by heating with ferric hydroxide.

Boiling with ferrous oxide, acidifying, and titrating with standard bichrome, I found the most practical way of decomposing and estimating the cobaltamine salt. With these experiments, as with the others preceding, the results were occasionally concordant, and often enough so

* Watts's Dictionary," ("Manganese"), vol. iii., p. 802.

to induce careful inquiry for a reliable application of the principle. But the measure of success was much the same as before. Cobaltamine salts are, as other chemists have asserted, partially unstable in warm alkaline solution. I have failed to obtain them stable in acid solution, and with prolonged boiling in presence of ferric salt they reduce entirely to the cobaltous state.

Further inquiry was now confined to one or two of the more likely suggestions current in chemical literature, although I confess to a dubiousness that in such any reliable volumetric method of determining cobalt in presence of unknown proportion of nickel would be found. At any rate, with the better examined processes their untrustworthiness in presence of much nickel is admitted, and re-investigation of same I considered profitless. The processes suggested for cobalt in pure solution alone are of no practical consequence, and, as already implied, the applicability of all others in presence of nickel is open to doubt, and regarded as such, I think, by chemists in general. I have considered only the methods whose merits or demerits are not definitely stated, and which, in fact, seem to lack the assurance of serious examination; and with my purpose so limited I have deemed an investigation of the methods devised by Dr. Fleischer and E. Donath as sufficiently comprehensive.

The various tests have been made with the sulphates of nickel and cobalt, the purity of which had been duly established. The sulphate of nickel is purchasable pure, but the cobalt salt rarely so; and the method adopted for eliminating its variable content of nickel and manganese I may briefly describe:—

The aqueous solution of the sulphate of cobalt was treated with potassium cyanide until the precipitate first thrown down had re-dissolved. Nitric acid was now added to the liquid until a yellowish turbidity appeared, and then bromine till the solution became strongly tinged. On alkalinising the hot liquid with caustic soda, and boiling off any ammonia if present, all the nickel and manganese, also a little cobalt, precipitated, and was removed by filtration. The filtrate evaporated to dryness, and fused in a platinum capsule, gave as the resultant a mixture of alkaline salt and oxide of cobalt, and on lixiviating the mass with water the former dissolved out, and the latter was thrown on to a filter and well washed. The filter and contents were ignited, dissolved in acid, and, after considerable dilution, precipitated with ammonium sulphide. The sulphide of cobalt was washed by decantation with several gallons of boiling distilled water, and then removed to a basin to be evaporated to dryness with nitric-sulphuric acid. The residue, dissolved in water and filtered, was re-evaporated, and ignited in muffle at low red-heat, to complete expulsion of free sulphuric acid.

In the product so obtained, and judging from the ordinary tests, the only detectable impurity was traces of ferric sulphate.

The other standard reagents comprised a bichrome solution, containing, per 100 grains of its volume, 0·55 grain pure potassium bichromate; and a solution of ferrous sulphate in dilute sulphuric acid, sp. gr. 1·14, and equivalent bulk for bulk to the standard bichrome just mentioned. One grain of the iron solution would consequently be equal to 0·00655 grain cobalt,—that is to say, to the oxydimetric value of cobalt considered as the sesquioxide. These solutions were delivered from burettes graduated to fifths of a div. (10 grains), but measurable to tenths, and the iron solution was standardised under conditions comparable with the actual experiments.

The use of these standard reagents will be indicated in the following description of Fleischer's process, and of its modification proposed by E. Donath:—

The nickel and cobalt in acid solution are precipitated with sodium hypochlorite and caustic soda, and the black sesquioxides boiled in the same liquid with excess of chlorine or bromine, to ensure their thorough oxidation. They are filtered, washed, and dissolved in excess of standard ferrous sulphate, and the non-oxidised iron titrated with permanganate (or with bichrome, as in my own experiments).

To estimate the cobalt alone, and to arrive in addition at the nickel by difference, Dr. Fleischer, in another experiment, boils the mixed hydroxides with a 3 per cent solution of ammonia. The nickel sesquioxide is reduced to nickel protoxide without the cobaltic hydroxide undergoing a corresponding change, and so in the subsequent operation the cobalt alone determines the oxidation of the iron.

E. Donath separately estimates the cobalt by precipitating a portion of the original solution with excess of caustic soda, adding iodine, and heating to the boil. The cobalt protoxide is oxidised to the sesquioxide, but the nickel protoxide remains without change.

The authors have described their methods in rather general terms, but I shall proceed to a more detailed consideration of my own experiments.

The cobalt solution containing 0·05 per cent of the metal was heated to the boiling-point, and for every grain of cobalt taken an addition of 1 oz. of strong bromine water made. Calcium carbonate in excess was added, and, on boiling for a minute or two, the precipitated oxide allowed to settle in the amber-coloured liquid. It was thrown on to a filter supported on a glass funnel provided with a syphon tube, and repeatedly washed with boiling water until the washings had long ceased to show an oxidising constituent. The filter and contents were then removed to a basin, and titrated with the iron and bichrome solutions.

I have calculated the oxygen contents of the precipitate to its oxydimetric equivalent of cobalt as the sesquioxide, and have appended a few of the results in Table I.

TABLE I.

Co taken.	Co ound.
1·89	2·08
,,	2·03
,,	2·05
,,	2·01
,,	1·98
3·79	3·91

These, it will be seen, as well as others I have thought unnecessary to give, are decidedly in excess of the truth, and that to an extent unaccountable by ordinary error of experiment.

In several cases zinc salt was added to the cobalt solution previous to its precipitation, and thus making the procedure similar in principle to Pattinson's well-known volumetric method for manganese. Yet, with this modification, the results still varied and exceeded the truth. It appears to me that for an adequate explanation of these facts we must assume the precipitation under the conditions of the process of "higher" oxygen compounds of cobalt than the sesquioxide.

Calculating from the experiment heading the list, the comparison of the precipitate might be represented as $4Co_2O_3 + CoO_2$; but of course compounds intermediate between the binoxide and sesquioxide may exist. It is also noteworthy that oxides of nearly similar composition were obtained by submitting a mixture of cobalt sulphate and "magnesia mixture" ($5NaHO + 3MgO$) to the red heat of a muffle. These and the hydrated oxides are practically stable in water and aqueous solutions of caustic soda, at their boiling temperatures.

It will be seen that the use of calcium carbonate in the above experiments is a slight departure from Fleischer's own procedure, but considered by me as more likely to effect the uniform precipitation of the cobalt. Still the alkalinisation of the original solution with caustic soda, and boiling of the precipitated liquid with excess of bromine, yielded results in practical agreement with those of Table I.

With the use of caustic soda as precipitant there is rendered evident, in the brisk effervescence of the preci-

pitated liquid, that peculiar and so-called "catalytic" decomposition of hypobromide into oxygen and bromide through the influence of cobaltic hydroxide.

I have already asserted that the higher oxides of cobalt in reaction with peroxide of hydrogen suffer reduction to the lower oxide $Co_{13}O_{19}$. It would seem that in presence of neutral or alkaline solutions of hypochloride or hypobromite they experience a like loss of oxygen; and the results of Table II. were obtained by boiling the precipitate with hypochlorite or hypobromite in absence of free chlorine, bromine, or acid.

Table II.

Cobalt taken.	Oxygen found.	Theory for Co_3O_4.	Theory for $Co_{13}O_{19}$.
1·89	0·7624	0·7720	0·7522
1·89	0·7624	0·7720	0·7522
3·79	1·5401	1·5480	1·5084
3·79	1·5124	1·5480	1·5084
3·79	1·5138	1·5480	1·5084

These results are rather in excess of the theory for $Co_{13}O_{19}$, but in all probability particles of the precipitate will escape the reducing action of the liquid.

It has evidently been overlooked by Dr. Fleischer, in his recommendation regarding the use of ammonia to reduce nickel peroxides, that the peroxides of cobalt themselves are subjected to a slight reduction, and the reduced product I find representable by the formula $Co_{13}O_{19}$. Furthermore, if the process devised by E. Donath had been subjected by its author to an examination, doubtless the fact would have been revealed that this oxide, $Co_{13}O_{19}$, or at least one with nearly the same proportion of oxygen, is the only cobalt oxide stable in presence of free iodine or salts of hydriodic acid.

If we treat the "peroxides"—designating by this term the oxides precipitated by calcium carbonate in a bromine-cobalt solution—with a boiling aqueous solution of iodine, they suffer reduction to the extent shown in Table III.c and the iodine is proportionately converted into iodi acid.

I show two experiments as typical of others:—

Table III.

Cobalt taken.	Oxygen found.	Theory for $Co_{18}O_{19}$.
1·89	0·7562	0·7522
1·89	0·7596	0·7522

If a boiling iodine-cobalt solution be precipitated with caustic soda, and afterwards or not treated with excess of iodine, an oxide is obtained excessively difficult to filter, and necessitating the addition of caustic soda to the wash-water to make the washing at all practicable. In several analyses its composition varied from—

$Co_{13}O_{19}(=6Co_2O_3+CoO)$ to $Co_9O_{14}(=Co_2O_3+CoO_2)$,

and I can only explain the differences by the probable difficulty of freeing the precipitate from traces of iodic acid.

On the other hand, by boiling the "peroxides" with 50 grains or so of potassium iodide, for ten minutes or longer, the composition of the readily filtered and washed precipitate was remarkably uniform, and, as seen from Table IV., still further indicative of the existence of cobalt oxide or oxides of high molecular weight.

Table IV.

Cobalt taken.	Oxygen found.	Co calc. from Oxygen as $Co_{18}O_{19}$.	Co calc. from Oxygen as Co_3O_4.
1·89	0·7596	1·94	1·79
1·89	0·7583	1·93	1·80
3·79	1·5138	3·85	3·57
5·69	2·2700	5·77	5·35

I have appended the third column to enable comparison with Table I.

I was not without hope that a method for volumetrically estimating cobalt in presence of nickel might be based on these results. Between the peroxides of nickel and potassium iodide the products of the reaction are nickel protoxide and potassium iodate.

Accordingly the bromine-nickel-cobalt solution, after precipitation with calcium carbonate, was boiled to expel free bromine, and the ebullition continued after addition of potassium iodide. Results in Table V.

Table V.

Taken.	Co calc. from $Co_{18}O_{19}$.
1·89 Co + 1·89 Ni	2·11
0·75 Co + 3·79 Ni	0·90

Thus we find the not unexpected difficulty to the practical success of the method in the physical aggregation of the precipitate partly protecting the nickel peroxide from contact with the reducing liquid.

And this closes my practical work on the volumetric estimation of cobalt in presence of nickel. I question the likelihood of any satisfactory process being based on these higher oxides of cobalt. Their constitution is probably more complex than as usually symbolled, and to the formation of a number of intermediate compounds may be attributable the variations of the above experiments.

The product of the reducing action of hydrogen peroxide on manganese binoxide would appear to me to be a distinct oxide, and as also indicative of high molecular weight of manganese peroxide; and, doubtless, the same holds good of the higher oxides of nickel. These nickel oxides have of course come in for a passing examination during the investigation. The results are in harmony with those of another observer. I discharge a duty to Prof. Bayley in mentioning certain researches of his on the higher oxides of nickel and cobalt (Chemical News, vol. xxxix., p. 81). I regret having overlooked the work of this chemist until my own experiments were completed, otherwise I would have considered an examination of Fleischer's process superfluous. Prof. Bayley, by operating on cold solutions of nickel and cobalt with sodium hypochlorite, obtained compounds of the composition Ni_3O_5 and Co_3O_5. On warming the solutions they readily decomposed,—the former to the oxide Ni_3O_4, and even lower; the latter to $Co_{12}O_{19}$, and compounds intermediate between this and the sesquioxide.

Having operated entirely on boiling solutions, the nickel oxides obtained by me varied in composition from Ni_6O_7, when obtained by treating the nickel solution with bromine and excess of caustic soda, to Ni_3O_4, on precipitating the solution with excess of hypochlorite.

On the whole my paper is mainly corroborative of facts already pointed out by Prof. Bayley, and perhaps may be considered as slightly amplifying the same line of inquiry in noting the behaviour of cobalt peroxide in presence of free iodine and salts of hydriodic, hypochlorous, and hypobromous acids, and also hydrogen peroxide and ammonium hydrate; and its reduction to somewhat near the composition $Co_{13}O_{19}$.

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A HOT BLAST OXYHYDROGEN FURNACE.

By H. N. WARREN, Research Analyst.

The above-mentioned furnace was constructed by lining an ordinary injector furnace, about 2 inches thick, by means of a paste composed of slaked lime and baryta, allowing the casement to dry, and afterwards raising the heat to whiteness in order to obtain a uniform calcareous coating possessed of little fusibility. The hot blast was constructed by admitting the gases through separate spiral tubes, ½ an inch in diameter and 7 feet in length, the pipe through which the hydrogen or coal-gas was led con-

sisting of an ordinary iron gas-pipe, coated exteriorly with fused boracic acid to prevent oxidation; the oxygen pipe being composed of fire-clay, and both being surrounded by a thick iron casing, pierced with numerous draught-holes, and provided with a chimney to increase the draught, the construction of each being similar to an ordinary combustion furnace, the fuel consisting of furnace coke in admixture with charcoal to aid the combustion. The pipes were then raised to a bright red heat, the extremities of each being simultaneously connected to the furnace blowpipe, the oxygen tube replacing the air blast. The furnace was now urged to whiteness by means of an air blast, and a crucible—made by drilling well-burnt quicklime and chipping as thin as possible—was introduced into the furnace, and containing pieces of quartz. The gasometer containing the oxygen gas was now turned on; the flame from the furnace was immediately reduced to one-half its original size, but became of intense brilliancy, and during the lapse of five minutes had entirely liquefied the rock crystal. Alumina was melted so completely as to be unrecognisable from native corundum, and of the same hardness. Calcium phosphate, ferric oxide, clay, and sandstone were rendered sufficiently liquid to be poured from the crucible, while platinum was quickly volatilised. Chromium, tungsten, and metals of the earths were readily reduced, but, owing to the heat softening the crucible, could not be obtained homogeneous. The heat obtained from the furnace when properly regulated is fully equal to that of an electrical furnace.

A NEW APPARATUS FOR MEASURING GASES AND MAKING GAS ANALYSES.

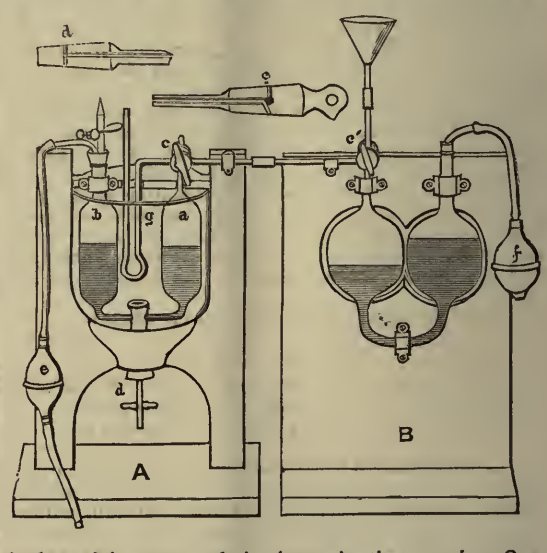
By E. H. KEISER.

In recent years the methods of gas analysis for industrial and technical purposes have been greatly simplified and improved, and are being used more and more extensively in manufacturing establishments. Much less progress has, however, been made in the more accurate scientific methods of gas analysis. While the labours of Orsat, Bunte, Winkler, and Hempel have resulted in bringing the methods of industrial gas analysis to such a condition of perfection that the composition of any gas mixture may be determined with great rapidity, and with a degree of accuracy sufficient for all manufacturing purposes, nevertheless, when more accurate results are required, recourse must be had to the older eudiometric methods of Bunsen. Admirable as these methods are, it cannot be denied that great skill is required to carry them out, and to obtain good results scrupulous attention must be given to all the minute details and precautions. The measurements being made in graduated eudiometers, it is necessary that the eudiometers should be calibrated, and tables of corrected readings constructed, before an analysis is made. There are inconveniences connected with the introduction and removal of absorbing reagents and as solid reagents are nearly always used, the absorption requires considerable time. In brief, the method is not at all adapted to making a series of rapid and yet accurate analyses.

Numerous forms of apparatus have been devised to overcome the difficulties of the Bunsen method. Among others, Regnault and Reiset,* Frankland and Ward,† Doyère,‡ and recently Hempel,§ have constructed instruments by means of which analyses can be made with as great accuracy as by the Bunsen method, and with much greater rapidity. Liquid instead of solid absorbing reagents are used, and the graduated measuring tubes are surrounded by water, so that an equality of temperature between the gas and water is rapidly obtained. All of these gas-measuring instruments are more or less complicated in construction. Graduated glass measuring tubes are used, thus necessitating a previous calibration. Most of them occupy a large space, and must be kept in separate rooms especially devoted to gas analysis.

It seemed therefore desirable to construct a simple gas-measuring apparatus which would be compact in form, which might be easily carried about and used at any place, and yet be capable of measuring gas volumes with great accuracy. Long graduated glass tubes and graduated vessels of all kinds were discarded, and an instrument was constructed upon the principle of determining the volume of a gas from the weight of mercury which it displaces at a known temperature and pressure. From the weight of mercury displaced the volume of the gas can be determined with much greater accuracy than by a direct reading on a graduated glass eudiometer.

The accompanying cut shows the construction of the measuring apparatus and the absorption pipette. A is the measuring apparatus, B is the absorption pipette; *a* and *b* are glass bulbs of about 150 cc. capacity. They are connected at the bottom by a glass tube of 1 m.m. bore, carrying the three-way stop-cock, *d*. The construction of



the key of the stop-cock is shown in the margin. One hole is drilled straight through the key, and by means of this the vessels *a* and *b* may be made to communicate. Another opening is drilled at right angles to the first, which communicates with an opening extending through the handle, but does not communicate with the first opening. By means of this, mercury contained in either *a* or *b* may be allowed to flow out through the handle, *d*, into a cup placed beneath. The bulb, *b*, is contracted at the top to an opening 20 m.m. in diameter. This is closed by a rubber stopper carrying a bent glass tube, to which is attached the rubber pump, *e*. To a second glass tube passing through the stopper, a short piece of rubber tubing with a pinch-cock is attached. By means of the pump, *e*, air may be forced into or withdrawn from *b*, as one or the other end of the pump is attached to the glass tube. The bulb *a* terminates at the top in a narrow glass tube, to which is fused the three-way stop-cock, *c*. The construction of the key of this stop-cock is also shown in the cut. By means of it the vessel *a* may be allowed to communicate with the outside air, or with the tube passing to the absorption pipette, or with the gauge *g*. The gauge *g* is a glass tube having a bore 1 m.m. in diameter and bent, as shown in the figure. By pouring a few drops of water into the open end of this tube a column

* Regnault and Reiset, *Ann. Chim. Phys.*, [3], xxvi., 333.
† Frankland, *Journ. Chem Soc.*, 1868, 109.
‡ Doyère, *Ann. Chim. Phys.*, [3], xxviii., 1.
§ Hempel, "Analyse der Gase," Braunschweig, 1880.

of water several centimetres high in both limbs of the tube is obtained. This serves as a manometer, and enables the operator to know when the pressure of the gas equals the atmospheric pressure. To secure a uniform temperature, the bulbs *a* and *b* are surrounded by water contained in a glass vessel. This vessel for holding water is merely an inverted bottle of clear glass from which the bottom has been removed. The handle of the stop-cock *d* passes through a rubber stopper in the neck of the bottle. A thermometer graduated to $\frac{1}{5}$° is placed in the water near the bulb *a*. The whole apparatus is supported upon a vertical wooden stand.

The absorption pipette B consists of two nearly spherical glass bulbs of about 300 c.c. capacity. They communicate at the bottom by means of a glass tube, 3 m.m. inside diameter. *c'* is a two-way stop-cock. The holes in the key are drilled at right angles, so that the tube which connects with the measuring apparatus may be put in communication either with the funnel or with the absorption bulb. The funnel is of service in removing air from the tube which connects the measuring apparatus with the absorption pipette. By pouring mercury or water into the funnel and turning the stop-cocks *c'* and *c* in the proper directions all the air is readily removed. *f* is a rubber pump used in transferring gas from B to A. The lower part of the pipette contains mercury, which protects the reagent from the action of the air.

To measure the volume of a gas the vessel *a* is filled completely with pure mercury. This is easily accomplished by pouring the mercury into *b*, and then, after turning *c* until *a* communicates with the outside air, forcing it into *a* by means of the pump *e*. Any excess of mercury in *b* is then allowed to flow out through the stop-cock *d*. When *a* and *b* are now placed in communication the the mercury will flow from *a* to *b*, and gas will be drawn in through the stop-cock *c*. The volume of mercury which flows into *b* is equal to the volume of gas drawn into *a*. When the mercury no longer rises in *b*, and it is desired to draw in still more gas into *a*, then it is only necessary to exhaust the air in *b* by means of the pump *e*. After the desired quantity of gas has been drawn into *a* the stop-cock *c* is closed. After standing a few minutes the temperature of the gas becomes the same as that of the water surrounding *a*. The pressure of the gas is then made approximately equal to atmospheric pressure, by allowing the mercury to flow out of *b* into a weighed beaker placed beneath the stop-cock *d* until it stands at nearly the same level in both *a* and *b*. Communication is now established between *a* and *g*, and by means of the pump *e* the pressure can be adjusted with the utmost delicacy until it is exactly equal to atmospheric pressure.

The stop-cock *d* is then closed, and the remainder of the mercury in *b* is allowed to flow out into the beaker. The weight of the mercury displaced by the gas divided by the specific gravity of mercury at the observed temperature gives the volume of the gas in cupric centimetres.

If it is desired to remove any constituent of the gas by absorption, a pipette, B, containing the appropriate reagent, is attached to the measuring apparatus. All the air in the connecting tube is expelled by pouring mercury into the funnel and turning the stop-cocks *c'* and *c* so that the mercury flows out through *c*. A little more than enough mercury to expel the gas in the vessel *a* is poured into *b*. The small quantity of air which is confined in the tube connecting *b* with the stop-cock is removed by allowing a few drops of mercury to run out through *b*. Then *a* and *b* are placed in communication. The stop-cocks *c* and *c'* are turned so that the gas may pass into the pipette, the mercury which filled the connecting tube passes into the absorbing reagent and unites with that which is already at the bottom of the pipette. The transfer is facilitated by the pump *e*. After absorption the residual volume is measured in the same way that the original volume was measured. *a* is completely filled with mercury from the upper to the lower stop-cock, and all the mercury in *b* is allowed to run out; the gas is then drawn back into the measuring apparatus, the last portion remaining in the connecting tube being displaced by means of mercury from the funnel. The volume is then determined as before.

The calculation of the results of an analysis is very simple. If the temperature and pressure remain the same during an analysis, as is frequently the case, then the weights of mercury obtained are in direct proportion to the gas volumes, and the percentage composition is at once obtained by a simple proportion.

If the temperature and pressure are different when the measurements are made, it is necessary to reduce the volumes to 0° and 760 m.m. The following formula is then used:—

$$V' = \frac{W(H-h)}{D\,(1 + 0{\cdot}00367 \times t)\,760},$$

in which

W = weight of mercury obtained (in grms.),
D = specific gravity of mercury at *t*°,
t = temperature at which the gas is measured,
H = height of the barometer,
h = tension of aqueous vapour,
V' = reduced gas volume (in cubic centimetres).

In all the measurements made with the apparatus the gas is saturated with aqueous vapour, because it comes in contact with the water in the manometer, *g*.

The following experiments were made to test the accuracy of the instrument. A quantity of air was drawn into the measuring bulb and its volume determined. The air was then transferred to an absorption pipette which contained only mercury and no reagent. It was then brought back again into the measuring apparatus and its volume re-determined. The following results were obtained:—

I.

	Volume at 0°—760 m.m.
Volume of air taken	57·558 c.c.
,, after first transfer	57·567
,, ,, second transfer ..	57·570

II.

	At 0°—760 m.m.
Volume taken	93·216 c.c.
,, after transferring	93·229

III.

	At 0°—760 m.m.
Volume taken	133·473 c.c.
,, after transferring	133·490

IV.

	At 0°—760 m.m.
Volume taken	92·275 c.c.
,, after transferring	92·260

V.

	At 0°—760 m.m.
Volume taken	109·025 c.c.
,, after transferring	109·020

VI.

	A 0°—760 m.m.
Volume taken	103·970 c.c.
,, after first transfer	103·955
,, ,, second transfer ..	103·980

The apparatus was also tested by making analyses of atmospheric air. It has been shown that the composition of the air varies from day to day.* This variation is sometimes as much as 0·5 per cent. The causes which produce these fluctuations in the composition of the atmosphere are at present but imperfectly understood. It is therefore desirable to have some simple instrument by means of which the composition of the air may be determined rapidly and yet with great accuracy.

* Winkler, "Industrie Gase," ii., 405. Hempel, *Berichte der deutsch. chem. Gesell.*, xviii., 267.

The following analyses show that the apparatus here described is well adapted to this purpose. The reagent used to absorb the oxygen and carbon dioxide was an alkaline solution of pyrogallol, prepared by mixing one volume of a 25 per cent solution of pyrogallol with six volumes of a 60 per cent solution of potassium hydroxide.

Analysis of Air taken from the Laboratory.

I.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Air taken ..	1738·53	743·37	15·8	116·435 c.c.	—
Vol. of nitrogen	1377·62	743·37	15·8	92·264	20·760
,, ,,	1376·40	743·55	15·75	92·255	20·771

Per cent of oxygen and carbon dioxide, 20·765.

II.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Vol. of air ..	1708·01	748·08	15·0	115·546 c.c.	—
,, nitrogen	1356·04	747·33	15·2	91·564	20·755

Per cent of oxygen and carbon dioxide found, 22·755.

The following analyses were made with a sample of atmospheric air collected on a subsequent day:—

I.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Vol. of air ..	1704·81	754·92	12·2	117·814 c.c.	—
,, nitrogen	1348·33	754·78	12·08	93·216	20·877
,, ,,	1344·71	755·92	11·7	93·229	20·868

Per cent of oxygen and carbon dioxide, 20·872.

II.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Vol. of air ..	1669·39	756·30	10	116·584 c.c.	—
,, nitrogen	1323·24	755·49	10·05	92·260	20·863
,, ,,	1322·38	755·30	10·00	92·252	20·870

Per cent of oxygen and carbon dioxide, 20·866.

The apparatus described in the preceding pages was made for the author, in most excellent manner, by Mr. Emil Greiner, 79, Nassau Street, New York.—*American Chemical Journal*, Vol. viii., No. 1.

COMPOSITION OF STROMEYERITE.

By GEORGE A. KOENIG, Ph.D.

Stromeyerite has been identified from Zacatecas, Mexico. At this locality the miners designate the various silver minerals by their colours, as black silver, red silver, green silver, and blue silver. Under the latter name—*plata azul*—several minerals are undoubtedly comprehended, but probably the most prevalent is the mineral here identified as Stromeyerite. One large specimen is composed of numerous prismatic crystals, the terminations broken off—resting on well-crystallised quartz, and from several smaller specimens it would appear that quartz is the ordinary associate of Stromeyerite at Zacatecas, while the other silver minerals—Proustite, Polybasite, Stephanite, Argentite—are more commonly associated with calcite. The faces of the crystals are rough, not admitting accurate measurements; the prismatic angle is near 120° to 119°. The mineral has no cleavage. Its fracture is uneven to flat subconchoidal, and very splintery. The lustre is brilliantly metallic and the colour iron-grey, with a strong bluish purple admixture. The colour of the powder is nearly the same. It is not sectile, but mild, and has a hardness of 3·5.

Sp. gr. = 6 2303, made upon 1·623 grms. of fragments from several crystals. Before the blowpipe it melts very readily to a globule, emitting sulphur dioxide, and changing to a grey globule of silver-copper. Gives no sublimate on charcoal, nor in open or closed tube, and dissolves in nitric acid, giving a blue solution, in which hydrochloric acid precipitates flocculent silver chloride.

A preliminary analysis made with a fragment from one crystal (0·2346 grm.) gave the result I.; a second analysis made upon the mixed fragments used in the determination of specific gravity (0·5 grm.) gave the result II.

I. $AgCl = 0·1615$; $Cu_2S = 0·0958$; $BaSO_4 = 0·2837$.
II. $AgCl = 0·2509$; $Cu_2S = 0·2105$; $BaSO_4 = 0·5758$.

From this we calculate—

	I.	II.
Insoluble	—	0·26
Ag	51·66	50·18
Cu	32·67	33·69
S	16·64	15·81
	100·97	99·94

Analysis II. having been made with twice the quantity of substance and with greater care, deserves alone to be taken as basis for the atomic ratio. Dividing the percentages by the atomic weights, we obtain—

$Ag : Cu : S = 0·4661 : 0·9983 : 0·4975$.
$Ag + Cu : S = 0·5322 : 0·4975$
$= 2·007 : 1$

Hence $47Ag_2S + 53Cu_2S$.

It is seen that Ag and Cu are not exactly in the ratio 1 : 1, but very near. Undoubted Stromeyerite has been described heretofore only from two localities, Schlaugenberg, in Siberia, and Rudelstadt, in Silesia, and from the latter place only, in crystals. The analyses of the mineral from these places do not give the ratio of 1 : 1 for Ag and Cu either, but a little closer than the present locality of Zacatecas. Since Ag_2S and Cu_2S may replace each other isomorphically in all proportions without question, we may look upon such a ratio as Stromeyerite demands, 1 : 1, as quite an exception, owing, no doubt, to peculiar conditions present at the time of crystallisation.

The material for this investigation was obtained from Dr. A. E. Foote, who collected it during his recent visit to Zacatecas and other mineral localities in Mexico.—*Journal of Analytical Chemistry*, Vol. i., Part 1.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending June 30th, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To The Water Examiner, *Metropolis Water Act*, 1871.

London, July 5th, 1887.

Sir,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from June 1st to June 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The condition of the water supplied to the Metropolis during the month of June did not differ substantially from that which has prevailed now for some months past; although, indeed, the proportion of organic matter present in the Thames-derived water, identical with that in the supply for April, slightly exceeded that met in the supply for the immediate preceding month of May. As for some months past, several samples of the East London Company's water were not wholly free from turbidity and consequent colour; but the proportion of organic matter present in this Company's water was exceedingly low, showing the turbidity to be entirely of a mineral and, apparently, an ochrey nature.

During the past six months we have examined 1057 samples of the water furnished to the Metropolis by the several companies taking their supply from the Thames and the Lea. In respect to the smallest of the proportion of organic matter present, the condition of the water has been throughout satisfactory. As regards freedom from turbidity, a failure in this particular was observable in several samples of Thames-derived water during the exceptional strain of a frost following a flood in the early part of January; and, as already mentioned, has been again noticeable recently in the East London Company's supply.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

NOTE ON STILLWELL'S METHOD OF OPIUM ANALYSIS.

By L. D. GODSHALL.

MR. C. M. STILLWELL (*Amer. Chem. Journ.*, viii., 295) has proposed a method for the analysis of opium, which is for the most part a modification of the method of Squibb. The chief novelty in the method consists in the use of saturated solutions of morphia for washing the crystals. My friend Mr. E. Luttgen, chemist for Keasbey and Mattison, has, at my suggestion, kindly compared this method with the one in use there (a modification of the method laid down in the U. S. P.) with the following results:—

Method of Keasbey and Mattison	(*a*)	9·95 per cent.
,, ,, ,,	(*b*)	10·00 ,,
Stillwell's method		10·05 ,,

Judging from this single comparison the method seems to be an accurate one. The only objection that suggests itself is that it is rather tedious. One point in connection with the method needs emphasis, viz., to conduct the evaporation in a shallow dish, as rapidly and at as low a temperature as possible, as otherwise morphia may be destroyed.—*Journal of Analytical Chemistry*, Vol. i., p. 23.

Manufacture of White Lead by means of Magnesium Acetate.—M. Kübel.—A strong solution of magnesium acetate rapidly transforms lead oxide into a soluble hydrate with an alkaline reaction. The precipitation of the lead in the state of carbonate is effected by means of carbonic acid so completely that the magnesium acetate may serve for a fresh operation. The proportions used are 1 part of magnesium acetate to 1½ of litharge; the acetate is made by acting upon magnesium carbonate with acetic acid at 7° Baumé; the liquid should contain 10 to 20 per cent of crystalline acetate.—*Dingler's Polyt. Journal.*

NOTICES OF BOOKS.

A. B. C. Five-figure Logarithms: or, Logarithms with Differences on a New and Simple Plan. By C. J. WOODWARD, B.Sc. London: Simpkin, Marshall, and Co.

Four-figure Mathematical Tables. By J. T. BOTTOMLEY, M.A., F.C.S., &c. London: Macmillan and Co. 1887.

NEXT to a good knowledge of figures natural'y comes the best and most expeditious manner of using them, and there is certainly no better method of simplifying calculations of all kinds than that of using logarithms. Their use is now extending with great rapidity, and many students can now devote to actual work a great deal of time and thought which they were formerly compelled to give to working out results and tables of comparison.

Mr. Woodward's Table of Logarithms are arranged so as to be in the most easy form for reference, and they are provided with all necessary references and instructions for use, so that even those who are not very well up in the subject will be able to use them after a short study.

After the Table of Logarithms we come to a Table of Factors to facilitate calculations in quantitative analysis, with exercises and examples, so that the reader can become quite familiarised with their working.

These tables will appeal specially to chemists, by whom no doubt they will be greatly appreciated. The tables have been framed on the principle that they should be of as few figures as possible, and be found with the least trouble, and we must congratulate Mr. Woodward on having so successfully carried out the task he set himself.

We must also speak in terms of high commendation of Mr. J. T. Bottomley's "Four-figure Mathematical Tables." They comprise not only logarithms, but tables of anti-logarithms, natural sines, logarithmic sines, natural and logarithmic cosines, tangents, co-tangents, secants, &c., radian measure, squares, roots, and reciprocals. We have ourselves had a copy of the first edition of this book in constant use for several years past, and can therefore vouch for the very excellent quality and character it possesses: that it has been duly appreciated by those for whose use it was prepared is shown by the fact that a further issue has now been rendered necessary.

The School of Mines Quarterly, Columbia College. New York. 1887.

THE number of this Journal now before us contains several articles of great interest both to mining engineers and others. The first, on Sub-surface Water, describes the method adopted along the line of the Brooklyn aqueduct, increasing the supply for the city to 18,000,000 gallons daily from this source alone: 460 two-inch tubes were driven from 40 to 70 feet into the gravel, and the water running into them is pumped up. The idea is not claimed as new, but it has been found to be so thoroughly effective that it may be said that new resources—though not *always* available—have been opened to the engineer. In large towns, where the quantity of water required is very great, it will not do to rely on the surface supply. A good but varying proportion of the rain-water sinks into the ground, and finds its way back to the sea by underground channels. In the country, where the needs are not excessive, an excavation is made, and the sinking of the well is stopped when water is reached,—one reason being that the appliances available do not enable the farmer to sink far into the wet ground; but the driven well goes much deeper, and the tube can easily be driven to the depth required to get a good constant supply. The question of exploring or prospecting for underground water is an important one, and one which should be systematically studied, or otherwise a good deal of labour may be uselessly expended in driving a well where there is no water.

The article on "Drift Mining" describes the method employed for obtaining gold in certain parts of California where the auriferous gravel has been covered with the great lava overflows of the Pliocene period. The present streams have cut deep channels, first, through the lava deposits, then through the gravel beds, and finally into the hard slates underneath: it was this erosion by the water which caused the formation of the gold-bearing river-beds, so extensively worked in the early days of Californian mining. In places where the miners found the gold gravel-deposits on the hillsides, they were gradually led underneath the ground as far as they could go, and were then obliged to stop for want of proper appliances. These deposits are now being slowly developed, but it requires a more skilful miner to make the preliminary surveys than in any other kind of mining; however, when properly worked, this method of "drift mining" generally gives a good yield.

A paper follows on the "Action of Sulphurous Anhydride on Benzene." The authors have repeated some experiments made by Friedel and Crafts, who found that a mixture of benzene and aluminium chloride absorbs sulphurous anhydride with great energy, forming benzene-sulphuric acid. After several trials they succeeded in obtaining a dirty yellow crystalline substance, which, when dissolved in xylol and left, formed small transparent crystals belonging to the triclinic system, and melting at 70° or 71°. Portions of this substance were subjected to different treatment, and diphenyl sulphone (melting at 128°) and diphenyl sulphide (boiling at 272°) were obtained.

Agricultural Science. Vol. i., No. 5. Edited by C. S. Plumb. Geneva, N.Y. 1887.

"Agricultural Science" is claimed to be the only Journal of its kind published in the English language dealing—as it does—with the purely scientific aspect of agricultural matters. No. 5 contains several articles: one by Sir J. B. Lawes, entitled "Some Remarks upon Foods"; one on the "Microbes of Nitrification"; "Researches on the Absorption of Ammonia by Clay," &c., followed by reviews of recent agricultural works and notes and abstracts of a variety of interesting matters of the same class.

Aids to Practical Chemistry. Especially arranged for the Analysis of Substances containing a Single Base and Acid Radicle. By J. Hurd Gordon. London: Bailliere, Tindal, and Cox.

This little book forms one of the "Students' Aid Series," which, as it is here said, are "specially designed to assist students in committing to memory and grouping the subjects upon which they are to be examined." The entire series appears to be especially arranged for persons whose object is to pass the primary examination of the Royal College of Physicians.

We are particularly struck with the definition of "radicles." Says the author, "By this term is understood bodies that are not saturated, and are therefore *unable to exist* until they have found something with which they are able to combine and thus become stable. These bodies are either elementary or compound. Chlorine, bromine, and sulphur afford examples of the former group." But experience certainly tells us that chlorine, bromine, and sulphur are perfectly able to exist uncombined. It is difficult to conceive how a body "unable to exist," or, in other words, non-existent, can seek and find something to combine with!

On page 9 we read a list of the ordinary colours of the salts of copper, iron, cobalt, nickel, and manganese, and are then told that "solutions of the commoner metals are generally colourless." Commoner than iron? Perhaps Mr. Hurd Gordon meant to say "solutions of the other common metals," or "solutions of the lighter metals."

The reactions given are those generally employed. We would, however, suggest that, in applying Marsh's test, the experimentalist should use only scraps of pure zinc or magnesium, as the zinc of commerce may contain arsenic enough to give indications of that element when not present in the body under examination.

A number of typographical errors might be advantageously corrected in case of a new edition. Thus, on page 10 we read of "Professor Olding's treatise," for Odling's; on p. 31 we find "silicates of soda of potash;" and on p. 33 "colourless gas ($CO+CO_2$) burns a mouth of test-tube."

A curious section is entitled "Examples of how to enter Results at Examinations." Here we find it stated that the non-occurrence of a precipitate with ammonia proves the "absence of members of Group II., also of oxalates and phosphates of Ba, *Sn*, and Ca." It is quite possible that a student may be here led astray.

The Retrospect of Medicine: being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by James Braithwaite, M.D. Vol. xcv., January to June, 1887. London: Simpkin, Marshall, and Co.

We find here an interesting account of poisoning due to inhaling the vapour of carbon disulphide. The symptoms closely resemble those of acute alcoholism. A certain proportion of workers in india-rubber are in a few months reduced to a lamentable condition of paralytic helplessness. Hence it is contended that such workshops should be placed under stringent regulations and be subject to the frequent visits of a Government Inspector.

In a note on the use of *Quillaja saponaria* in bronchitis we find mention of the remarkable power of this drug—Panama bark—in saponifying oils, which may explain some of its known uses in the arts, and suggest others.

To medical practitioners the "Retrospect" continues to present the same features which have for many years secured for it the all but universal patronage of the faculty.

CORRESPONDENCE.

DETERMINATION OF SULPHITES IN THE PRESENCE OF HYPOSULPHITES AND SULPHATES.

To the Editor of the Chemical News.

Sir,—We beg to call your attention to what seems to us an error in the article on the "Qualitative Determination of Sulphites in presence of Hyposulphites and Sulphates," in Chemical News, vol. lv., p. 242.

The author states that "if we treat a solution of an alkaline bisulphite with barium chloride there is formed neutral barium sulphite, and half the sulphurous acid remains in solution."

Having much to do with bisulphite solutions in connection with processes for making wood-pulp, we, some time ago, attempted to found a process for the estimation of actual bisulphite in a given solution upon the above-mentioned reaction, but without success.

We find that the sulphurous acid left in the solution is exactly one half of the total amount present as bisulphite in the original solution only in special cases, since, allowing a little time for the reactions to become complete, the amount of sulphurous acid in solution reduces to a constant quantity for a given temperature, viz., about 0·15 per cent at the ordinary temperature.

This holds true for magnesium as well as alkaline bisulphite solutions.

It appears to us also that the sulphurous acid remaining in solution exists, not as free acid, but in combination as barium bisulphite, and that its amount is dependent on the solubility of the latter in the menstruum, since, on heating the solution, SO_2 is given off, and we obtain a precipitate of neutral barium sulphite; and also from the fact that the solution (containing an excess of barium chloride) may be directly titrated with soda solution, using phenol-phthalein as indicator, with the same result as obtained from the titration with iodine; but with the simultaneous precipitation of neutral barium sulphite according to the following equation—

$$(BaSO_3,H_2SO_3) + BaCl_2 + Na_2O = 2BaSO_3 + 2NaCl + H_2O.$$

We have found, however, that if we treat a solution containing neutral and bisulphites together with sulphates, with an amount of neutral acetate of lead equivalent to the total amount of sulphur acids present, we have left in the solution free acetic acid equivalent to exactly one half of the sulphurous acid present as bisulphite in the original solution, and which may be titrated with alkali.—We are, &c.,

GRIFFIN AND LITTLE.

103, Milk Street, Boston, Mass.,
June 27, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 25, June 20, 1887.

Application of the Electrometer to the Study of Chemical Reactions.—E. Bouty.—The calculations which the author has presented in a former memoir (*Comptes Rendus*, civ., p. 283) solve, in principle, the problem of the application of the electrometer to the study of chemical reactions. Since we can calculate the conductivity, x, of a mixture where there is no chemical action, we have only to compare x with the conductivity, C, as measured. If there is even a slight difference it is the certain sign of a reaction, the intensity of which is approximately proportional to the difference $C - x$. The author takes, as an example, a mixture of potassium sulphate and sulphuric acid.

Researches on Certain Sulphites.—P. J. Hartog.—A thermo-chemical paper. The author shows that the double ammonium-magnesium sulphite is formed with a considerable liberation of heat, which supports the view of M. Berthelot of the existence of ammonium-magnesian bases, which combine with acids with a greater liberation of heat than the separate bases.

On the Potassium Manganites.—G. Rousseau.—The decomposition of potassium manganate by heat passes through a series of successive states, which are reproduced in an invariable order either in the absence or the presence of watery vapour. The thermic effect due to the combination of water with anhydrous potassa lowers the temperature corresponding to each of these states, and the continuous elimination of oxygen prevents the partial regeneration of the manganate and accelerates the progress of the phenomena.

Dissociation of Hydrated Oxalic Acid.—H. Lescœur.—The use of oxalic acid as a starting-point in alkalimetry was proposed by Mohr in 1852. Like many chemists he thought that this product, if exposed to the free air, contains always exactly 2 mols. of water. The author, and before him Erdmann, Winkler, Hampe, and others, have remarked that crystalline oxalic acid often contains more water than the theory allows. The use of anhydrous oxalic acid, proposed as more exact, is not practical. The author prefers to place the stock of crystalline oxalic acid under a bell over sulphuric acid at 53° B. At the ordinary temperature it does not effloresce, but merely loses excess of water, and presents then an absolutely constant composition.

Residues extracted from Steels and Zincs by Acids.—MM. Osmond and Weith.—If re-heated steel is attacked by dilute hydrochloric acid at the positive pole of a Bunsen element, there is isolated a skeleton formed of graphitoidal tablets, composed essentially of iron and carbon; but they contain, also, water in proportions varying with the conditions of the experiment, and generally an excess of oxygen. These residues, like those which have been studied by M. Debray, explode if dried in a hot air bath. Hence they have to be dried in a vacuum, and even then they are liable to spontaneous combustion.

Certain Reactions of the Vanadates and on their Use in Chemical Analysis.—Ad. Carnot.—The solubility of the alkaline vanadates renders them unfit for determination. Ammonium vanadate alone can serve for the determination of vanadic acid, by reason of its almost absolute insolubility in a liquid saturated with sal-ammoniac, and mixed with alcohol. But this reaction can serve only in very restricted cases; it requires very concentrated solutions, and is adapted neither to the separation of bases other than the alkalies, nor to that of acids, especially the phosphoric and arsenic. The determination of vanadic acid in presence of alkaline and ammoniacal salts may be effected much more easily in the state of barium vanadate under the following conditions. If the solution is acid it is saturated with ammonia as exactly as possible; it retains at first a yellow colour, but it is quickly decolourised on boiling. There is poured into it then a solution of barium chloride; it is stirred, and the white precipitate formed is allowed to settle. It is observed if fresh turbidity is produced by a further addition of this reagent, and that the ammoniacal odour is very slight. The flask is stoppered and let cool rapidly. All the vanadic acid is deposited as bibarium vanadate, which is received on a filter, washed with cold water, dried, and ignited. It is then of a white, slightly yellowish colour, and contains 37·372 per cent of vanadic acid. The filtrate does not retain any trace of vanadium. If, after the precipitation of the barium vanadate, it is boiled for some minutes, the precipitate attaches itself in great part to the sides of the flask. It becomes very difficult to collect and to weigh, but it can be thus very easily separated by decantation from the liquid, which may be turned to account, as it will be seen below. The salts of strontium do not give rise to the same reaction. If added to a vanadic solution, very slightly ammoniacal, but charged with sal-ammoniac, they produce no deposit either in cold or heat (if only the liquid contains no carbonate and is not left in contact with the air). The phosphates and arseniates, on the contrary, are precipitated by strontium salts under the same conditions. This difference of action may serve for separating *vanadic acid* from *phosphoric and arsenic acids*, which often accompany it in nature (vanadinite, descloizite, bauxite, iron ores, &c.). The same reaction may be used for the separation, at least approximately, of vanadic acid from molybdic and tungstic acids. The two latter are also precipitated on boiling as strontium salts in a slightly ammoniacal liquid, saturated with sal-ammoniac. But the precipitation is not rigorously complete. Lastly, a separation of baryta and strontia may be based upon the very distinct reaction just mentioned. We may proceed as follows:—The solution containing salts of barium and strontium is mixed with sal-ammoniac, and then saturated with pure ammonia free from carbonate. A dilute solution of ammonium carbonate is added and boiled for some

minutes. The precipitate of barium vanadate is formed at once in the state of heavy granules, which adhere to the glass. It is let cool with exclusion of air, decanted, and washed in cold water. In the liquid the strontia is precipitated by ammonia and ammonium carbonate, ignited, and weighed as strontium carbonate.

Transformation of Maleic and Fumaric Acids into Aspartic Acid by the Direct Fixation of Ammonia.—M. Engel.—Maleic and fumaric acid take up directly the elements of ammonia, and are thus converted into inactive aspartic acid. If the transformation is not total it is because aspartic acid is partially decomposed by water at 140° to 150°.

New Chloro-derivatives of Anisol.—L. Hugounenq.—The author has obtained several novel compounds, a dichloro-derivative, two trichloro- and two tetrachloro-compounds. All are permanent and volatile.

Archives Neerlandaises des Sciences Exactes et Naturelles.
Vol. xxi., Part 5.

Condition of Bodies after Arsenical Poisoning.—T. Zaaijer.—An occurrence, fortunately very rare, gave the author the opportunity of testing the opinion that the corpse of any person poisoned by arsenic undergoes a kind of mummification, and that such mummification is, to a certain degree, proof that death has been occasioned by arsenical poisoning. The wife of Johannes van der Linden was convicted, at Leyden, of having fatally poisoned four persons with arsenic. *Nineteen* other fatal cases were not judicially decided on, and, in addition, 36 persons had been rendered ill by arsenic administered by the same lady. The author, in conjunction with Dr. P. de Konig and Dr. E. A. van der Burg, was commissioned to examine the bodies of 16 of the victims, some of them two or three years after burial. His conclusions, which are of great importance for the toxicologist, are that:—The mummification of a corpse is a matter of very frequent occurrence. Check observations, made both by others and by the author, prove that bodies free from arsenic, if placed in the same conditions as bodies containing arsenic, resist putrefaction as well as the latter, and may also become mummified. The relatively frequent mummification of the sides of the abdomen and thorax, of the skin enclosing the joints of the wrist, the knee, and the ankle, and the skin of the fingers and toes, can easily be explained, independently of any influence of arsenic. The so-called "arsenical mummification" has no existence, especially for fatal doses. The mummification of a corpse has no value as a judicial proof of poisoning.

Journal für Praktische Chemie.
New Series, Vol. xxxv., Part 5.

Critique of the Foundations and Results of the so-called "Theory of the Formation-Heat of Organic Bodies.—J. W. Bruehl.—The author sums up by concluding that Prof. Thomsen's so-called theory of formation-heats is not suitable for investigating the atomic composition of bodies, and that any arguments drawn from it against Kekulé's benzol formula, or generally speaking for or against any view on the chemical constitution of organic bodies, are worthless.

Chemical Examination of the Schützenhof Spring at Wiesbaden. — H. Fresenius. — An exceedingly elaborate analysis of this mineral spring, more interesting medicinally than chemically.

The Formation of Indigo Blue from Ortho-nitro-phenyl-propiolic Acid by Means of Potassium Cyanide.—A. Michael.—If a solution of sodium ortho-nitro-phenyl-propiolate is heated with pure potassium cyanide and some glucose, there falls, in a short time, a precipitate of indigotine. The same reaction occurs if hydrocyanic acid is added to the above solution, even in large excess, and it is then heated to boiling. If the solution of the salt is heated with potassium cyanide without the addition of glucose, indigotine is not formed, but certain intermediate products.

On Allo-isomerism in the Crotonic Acid Series.—A. Michael and G. M. Browne.—The authors give a tabular view of the properties of the three known bromo-crotonic acid from which the isomerism of the new acid discovered by the authors appears.

A New Gas Burette. — B. Franke.— This memoir requires the accompanying diagram.

Action of Nitrous Acid upon Ortho-amido-benzamide.—A. Weddige and H. Finger.—On adding to the acid solution of 1 mol. ortho-amido-benzamide hydrochlorate or nitrate 1 mol. of sodium nitrite dissolved in water, a crystalline substance separates out in the form of yellow or brownish-yellow needles. It is readily soluble in hot water, from which it crystallises out in the form of pale rose-coloured needles. From a solution in benzol it separates out in shining leaflets. It fuses with decomposition at 213°. Its empirical formula is $C_7H_5N_3O$. The new substance is therefore an ortho-amido-benzamide, in which three atoms of hydrogen are replaced by an atom of nitrogen. It has acid properties; it dissolves readily in alkalies and ammonia, and is re-precipitated unchanged by acids.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxviii., Part 3.

Researches on Gold (Second Treatise). — Gerhard Krüss.—The author here examines neutral and sublimed auric chloride and potassium-auric bromide, which exists in three modifications. He has determined the atomic weight of gold by five distinct methods, making, in all, 30 determinations, and arrives at the mean value 196·669. The mean numbers of sixteen experiments fell below 196·669, whilst fourteen showed a higher atomic weight. Two of the methods indicated higher atomic weights, whilst the three others pointed to a lower value, and in these three the difference between the maximum and the minimum result was the slightest. Hence Krüss proposes 196·64 as the atomic weight of gold. If we assume O = 16 the atomic weight of gold would be 197·13. With the figure 196·64 gold fits perfectly into the natural system of the elements.

On the Speed of Saponification.—L. Th. Reicher (Third Treatise).—This memoir does not admit of useful abstraction.

Acids formed from Levulic Acid after the Addition of Hydrocyanic Acid, γ-Methyl-hydroxylglutaric Acid, and Methyl-gluto-lactonic Acid.—J. Block, K. Kreckeler, and B. Tollens.—The main results of this investigation are:—Levulic acid, by the addition of hydrocyanic acid, yields a crystalline cyan-valero-lacton, $C_6H_7NO_2$, and this, if heated with hydrochloric acid, passes into a crystalline monobasic γ-methyl-gluto-lactonic acid, $C_6H_8O_4$, but if boiled with bases it forms salts of the bibasic γ-hydroxy-γ-methyl-glutaric acid, $C_6H_{10}O_5$. The latter acid, when set free, passes into the above-mentioned lactonic acid; γ-methyl-gluto-lactonic acid is re-converted into levulic acid if heated with sulphuric acid, carbon monoxide being given off. Besides cyan-valero-lactone there is formed a crystalline amide of γ-methyl-gluto-lactonic acid.

Certain Salts of Levulic Acid.—Dr. J. Block and B. Tollens.—A description of the barium and strontium salts. The magnesium salt has been obtained only as a gummy mass.

Origin of Galactose and Levulose from Raffinose.—J. Haedicke and B. Tollens.—The authors infer from their observations that the inversion products of raffinose yield mannite and dulcite on hydrogenisation, which confirms their result that raffinose, on inversion, yields

galactose and levulose. The former of these compounds yields dulcite and the latter mannite on treatment with sodium amalgam.

On Galactose from Carragheen Moss.—J. Haedicke, R. W. Bauer, and B. Tollens.—The group yielding mucic acid, which appears as galactose on heating with sulphuric acid, is plentifully found in Carragheen moss.

Communications from the Chemical Laboratory of the University of Geneva.—These communications include papers by C. Graebe, on tetra-chlor-phthalic acid; by G. Kircher, on tetra-chlor-ortho-benzoyl-benzoic acid; by A. Le Royer, on β-dichlorphthalic acid; and by C. Graebe, on the boiling-points of diphenylamine and of its homologues.

A Preparation of Para-dinitro-dibenzyl.—W. Roser.—This compound is obtained by reducing para-nitro-benzyl chloride with a strongly alkaline solution of stannous chloride.

The Tannin of Oak-wood.—Dr. Carl Böttinger.—The tannic acid of oak-wood seems to have the composition of a digallic methyl-ether. Its constitution must differ essentially from that of true tannin, as appears from its behaviour with bromine and alkalies.

Vol. ccxxxix., Part 1.

On the Terpenes and the Ethereal Oils. — O. Wallach.—The following terpenes can now be clearly distinguished :—Pinine, camphene, limonene, dipentene, terpinoline, sylvestrine, terpinene, and phellandrene.

Communications from the Chemical Laboratory of the University of Geneva.—These include researches by A. Bonna, on phenyl-paratoluidine; by N. Dobreff, on orthodibenzyl-dicarbonic acid; by S. Racine, on certain derivatives of orthotoluylic acid; and, by the same author, on phthalaldehydic acid.

On New Compounds of Benzyl and Benzoyl.—C. A. Bischoff and H. Siebert.—This memoir does not admit of useful abstraction.

Action of Iodine upon the Derivatives of Sodium Malonic Ester.—C. A. Bischoff and A. Hausdoerfer.—This paper also is not adapted for abridgment.

MISCELLANEOUS.

Coal Tar and Ammonia.—Messrs. Gurney and Jackson will shortly publish Professor Lunge's "Coal Tar and Ammonia," being a new and very much enlarged edition of the author's "Distillation of Coal Tar," published by Mr. Van Voorst in 1882.

Messrs. F. Sartorius, of Göttingen, have just issued a new price list of the chemical and physical apparatus made by them. They make a large number of chemical and other balances; and their patent short-armed balances, with all recent improvements, are excellent instruments, and can be had at a very reasonable price.

City and Guilds of London Institute.—On Friday last, July 15th, the Students at the Technical College, Finsbury, gave their third *Conversazione*. Popular Lectures were delivered by Prof. W. E. Ayrton, F.R.S., and Prof. Meldola, F.R.S. There were, in addition to these lectures, n ierous other attractions, including two concerts, whi could be heard either in the Concert Hall or by telepho : in another room, and a great variety of machinery and apparatus used in the College, together with models and machines actually made by the Students. We must not omit to mention the chemical exhibits lent by Messrs. Boake and Co., Townson and Mercer, Hopkin and Williams, and many others. Messrs. Beck and Co., Crouch, Cetti, and Maignen were also represented here, the first-named firm showing, besides a score or more of microscopes, the grinding of lenses. Dr. Curtius, of Erlangen, sent a sample (the first seen in England) of his latest discovery, hydrazine sulphate; and a large number of coal-tar products were laid out for inspection. The electrical department, however, yielded the palm to none for the number and beauty of their exhibits, which we have no space to detail. We must heartily thank the Students for their splendid entertainment, and congratulate Professors Thompson, Perry, and Meldola on having such energetic students under them.

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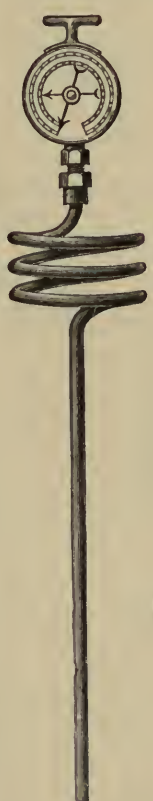

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THE CHEMICAL NEWS.

VOL. LVI. No. 1444.

NOTES ON THE GROUP OF RARE EARTHS, CONSIDERED *A PROPOS* OF MR. CROOKES'S THEORY OF THE GENESIS OF ELEMENTS.

IN Vol. xvii., No 5, of the *Archives des Sciences Physiques et Naturelles* there is a long article by M. de Marignac on the Group of Rare Earths in which he discusses and criticises my recent lecture delivered at the Royal Institution on the "Genesis of the Elements. Everything that M. de Marignac writes, especially on the subject of the rare earths, upon which he has worked so long and so successfully, is deserving of the most respectful attention, and I certainly should not have ventured to criticise any remarks which he might make on my own researches had he not admitted in this paper that he may have imperfectly understood my arguments owing to want of familiarity with the English language. In some few particulars he has mistaken my meaning, and I therefore take the opportunity in reviewing this article of pointing out what these mistakes are and where they occur. After briefly commenting on the first part of the lecture he goes on to say that "Mr. Crookes admits the existence, at the beginning of time, of a primordial matter uniformly distributed throughout space, which he proposes to call protyle. It was not then matter as we now know it, in one of its solid, liquid, or gaseous forms, for it was still uncondensed into atoms; it was probably in that ultra-gaseous state which he calls 'radiant matter,' to which he assigns those particular properties which can be observed in bulbs wherein the gas has been reduced to a pressure of less than one-millionth of an atmosphere."

In this conjecture M. de Marignac has not exactly caught my meaning. "Radiant matter" is highly rarefied gaseous matter acting under the influence of the electric discharge in a high vacuum. "Protyle" is the name given to that hypothetical substance, so to speak, which existed before matter as we now know it was formed, and from which it is conjectured atoms were made.

The next point of interest is connected with this theory of the formation and possible difference in the weight of atoms of the same elements. It runs as follows :—

"I will mention one point of this theory, and that is, that, according to the manner of formation admitted by the author, he considers it possible that the atoms of any particular element may not be all of exactly the same weight, and that when we say, for example, that the atomic weight of calcium is 40, it is possible that it is formed principally of atoms weighing 40, and to a small degree of atoms of 39·9 and of 40·1, and in a still smaller degree of atoms weighing 39·8 and 40·2, &c. One can conceive more easily in this hypothesis, that by very delicate chemical means we might succeed in separating a body reputed simple into several distinct but almost identical bodies.

"I have still less the intention of criticising Mr. Crookes's theory. I have always admitted* the impossibility of accounting for the curious relations which are manifested between the atomic weights of the elements, except by the hypothesis of a general method of formation, according to definite though unknown laws; even when these relations have not the character of general and absolute laws. I am, therefore, in perfect agreement with Mr. Crookes on the basis on which the question rests. As to the details of his theory, I have no means of disputing them, since they all rest on hypotheses whose experimental demonstration is, and for a long time will be, impossible.

"But among the arguments brought forward by Mr. Crookes in support of his opinion, there is one which depends on the consideration of facts about which there should certainly be some reserve, if only to prevent their concordance with a theory, without doubt very hypothetical, as the author himself admits, but still possessed of a great degree of probability, contributing to confirm in it an appearance of certainty which does not appear to me to be sufficiently established."

After mentioning the method of fractionation employed in the separation of the rare earths, M. Marignac goes on to say :—

"As for the chemical properties of these new earths, Mr. Crookes does not think there can be any other difference between them beyond a more or less pronounced basic energy, which permits their gradual separation by means of fractional precipitation by ammonia. He admits, although without bringing forward any evidence to prove it, that they are all of the same atomic weight. But the most remarkable fact is the absolute identity of all their spectra, when examined by the ordinary methods of spectrum analysis, such as by submitting a solution of the chlorides to a strong electric discharge."

I must here remind my readers that I have not yet admitted the identity of these atomic weights, and further that it is by no means established that the spectra referred to are identical.

M. de Marignac next proceeds to the consideration of two theories which I considered possible explanations of the facts observed, and suggests the possibility of a third hypothesis. "If I now bring one forward," he says, "it is not because I attribute to it a greater degree of probability than that possessed by the two preceding ones. Far from it. But I do not see that the facts stated by Mr. Crookes suffice to reject it as inadmissible, and I regret that he himself has not mentioned it, even to show its failings, nobody being better able than himself to show if it is or is not in agreement with the numerous experiments that he has made during the past few years.

"Perhaps, in collecting all the proofs for this refutation, he might have been led to try new experiments, which would have removed all doubts.

"Mr. Crookes has shown that an earth* which, by itself when pure, viz., oxide of samarium, gives but a feeble phosphorescent spectrum, produces a much more brilliant one when mixed with lime, and that this spectrum is still evident when the proportion of this earth in the lime is reduced to one millionth, and even less."

M. de Marignac then goes on to say—"It is true that this method, so delicate in certain cases for recognising the presence of a body in a mixture, is, at the same time, so capricious, that when this same oxide of samarium is mixed with yttria it in no way changes the spectrum of this latter earth so long as its proportion in the mixture does not exceed 35 per cent; on the other hand, the spectrum of yttria disappears, and leaves nothing but that of samaria when the proportion of samaria exceeds 43 per cent. Could we not then suppose that the fractional precipitations to which yttria has been submitted have only effected the accumulation at the two extremities and in some of the intermediate places, some imponderable traces of other metallic oxides, whose presence cannot be proved by chemical analysis, and whose nature would be more difficult to recognise, inasmuch as it might be their presence in yttria which conferred upon that body the property of emitting phosphorescence."

In reference to the theory which M. de Marignac advances, I at once admit that it is most reasonable, and one which may probably explain many of these obscure phenomena. A similar explanation occurred to me some time ago, and it is identical with one I published in

* "See for example the remarks I made in 1860 and 1865, after the publication of M. Stas's researches on atomic weights (*Archives*, ix., 102; and xxiv., 376)."

* *Comptes Rendus de l'Académie des Sciences*, vol. c., p. 1495.

January last* as one of the possible explanations of the variation in the spectra of another earth which I was submitting to fractionation.

In speaking of the similarity of the spectra of Yα, and a mixture of 61 parts of yttria and 39 parts of samaria M. de Marignac says:—

"My first impression was that Mr. Crookes meant that my earth was really nothing more than a mixture of yttria and samaria. Now, such an opinion on my part is untenable in presence of the facility with which one can succeed, if not exactly, in separating these two earths one from the other, at least in proving their existence, by precipitating their solution by sulphate of potassium; yttria is, in fact, soluble in thirty times its weight of a saturated solution of the salt, while samaria requires about 1000 parts.

"But how can I attribute this opinion to the learned chemist who has expressed himself in so precise a manner on the necessity of controlling, by rigorous chemical means, the results which spectroscopy has indicated.† Still less can I do so, since Mr. Crookes knows better than anybody the characteristic properties of gadolinia, having stated, as he has, that in samarskite he came across an earth, identical in its chemical and spectroscopic properties with the one which I discovered."‡

M. de Marignac is not quite accurate here. The point I wished to insist upon was that the spectrum of the mixture gave the Yα spectrum together with the very brilliant line of Gδ. The earth Yα, both of M. de Marignac's and of my own preparation, gave a spectrum free from the Gδ line, but consisting of other lines which occur in the spectra of yttrium and samarium. I thereupon said, if it were possible to remove Gδ from this mixture, I should leave Yα behind. I did not exactly "come across" an earth in samarskite similar to Yα, but obtained it by submitting the yttria earths (roughly purified) from that mineral to a most severe course of fractionation.

M. de Marignac then dwells at some length on the question of the atomic weights of yttrium, and quotes several analyses and estimations made by M. Nordenskiöld in which the atomic weight varies between such wide limits as 238·7 and 312·0, after which he concludes—

"If we notice that the earths which accompany yttria have molecular weights generally much higher than it has, and not differing much from each other (ytterbia, 392; erbia, 380; Yα, about 362), I believe that all we can be sure of is that this earth is always met with in nature mixed with a variable number of other analogous and isomorphous earths, of a much higher molecular weight, and generally preponderating in the mixture.

"Mr. Crookes is therefore not justified in saying that we have proof of the existence in nature of a mixture of isomorphous bodies always associated together, and having an atomic weight as constant as if they constituted a simple body.§

"I do not the less acknowledge that the fact of constant association of these elements is one of the strongest proofs that can be found of the community of the origin. Besides it is not an isolated fact; we can find other examples, such as the habitual association in minerals of tantalum, niobium, and titanium."

A Carbohydrate contained in Acorns. — MM. Camille Vincent and Delachanal.—The compound in question, to which the authors propose to give the name quercine, is a hexatomic alcohol, isomeric with inosite, from which it differs by its crystallisation, by its melting-point, which is 342°, in place of 217° (inosite); by the higher melting-point of its hexacetyl derivative, and by its much slighter solubility in water.—*Comp. Rend.*, No. 26.

* *Proc. R. S.*, vol xlii., p. 26, and Chemical News, vol. lv., p. 25.
† *Comptes Rendus de l'Academie des Sciences*, vol. c., p. 1497.
‡ *Ibid.*, cii., p. 646.
§ These were Professor Nordenskiold's words, not mine.—W.C.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.
Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

This plant is well known in the West as the "soap-weed." It grows very abundantly in most of the Western States and Territories. It has attracted the attention of botanists, and it is a plant of interest on account of the many uses to which it has been put in the countries where it is found.

The results noted in this paper are based upon a first and introductory chemical analysis of the *Yucca*. Previously, little has been studied of its chemistry. It is briefly mentioned in the work of a French writer, Dr. Georges Pennetier†; also in a paper on the study of manganese found in the ash of plants, in which M. Maumené states that the ash of the *Yucca* contains manganese.‡ He does not name what species of *Yucca* was examined. The former writer gives the micro-chemical characters of the action of iodine and sulphuric acid, dilute chromic acid, and cuprammonia on the fibres of the *Yucca angustifolia*.

The specimens of *Yucca* used in these analyses were of large growth and in good condition. The entire plant was examined, and a separate study made of the bark and wood of the root, and of the green leaf and the yellow basal part. The roots were air-dried, freed from adherent dust, reduced to a very fine powder, and passed through a No. 80 sieve. The leaves were less finely powdered.

Dragendorff's scheme for plant analysis§ has been generally followed. 10 grms. of the air-dried powder were used for the preliminary examination of soluble substances. For every grm. of the powder 10 c.c. of the solvents were employed. An additional quantity of the powder was prepared for special purposes. 5 grms. of the air-dried powder were dried in a hot-air oven at a temperature between 100° C. and 110° C. until the weight remained constant, for the estimation of moisture. This powder was incinerated in a covered porcelain crucible at a dull red heat until the carbon was entirely consumed. The per cent of total ash was determined from it.

Qualitative Ash Analyses.

Calcium, magnesium, potassium, sodium, iron, manganese, chlorides, phosphates, and sulphates were found in every part of the plant.

Determination of { I. *Moisture* / II. *Total Ash* } *on the Powder.*

	I.	II.	Colour of Ash
(1). The bark of the root	6·78 p.c.	17·38 p.c.	Reddish.
(2). The wood of the root	11·67	15·75	,, grey.
(3). The green leaf .	8·11	5·75	Grey.
(4). ,, yellow base of leaf	37·00	10·63	White.

Petroleum Spirit Extracts.

Extract (1) *Bark of Root.*

The maceration was conducted in an apparatus similar to one described in Dragendorff's "Plant Analysis."‖ A light petroleum spirit was used, which boiled between

* Reprinted from the *Transactions of the American Philosophical Society.*
† "Lecons sur les Matières Premièr s Organiques," Paris, 1881 p. 446
‡ M. E. J. Maumené, *Bull de la Société Chimique de Paris*, Tome xlii., p. 305.
§ "Plant Analysis: Qualitative and Quantitative," by G. Dragendorff. Translated from the German by Henry Greenish, London 1884.
‖ P. 99. Tollen's apparatus.

25° C. and 45° C. The *extract* was filtered from the powder-residue. It was a clear pale yellow-coloured liquid, and slightly acid in reaction. A drop of the *extract*, on evaporating, left a uniform spot on blue paper. The *extract* was evaporated at the ordinary temperature. The *residue* was a solid, and it had the odour and characteristic crystalline structure of fatty acids, suggesting the presence of a fixed oil. Its melting-point was taken. The substance melted at 60° C., and, on cooling, solidified amorphous. To determine the total amount of solids extracted, a definite volume of the *extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Petroleum spirit residue dried at 100° C. ..	1·24 of solids.
,, ,, ,, 110° C. ..	1·20 ,,
	0·04 of loss.

The *residue* was identified as a fixed oil. It was soluble in petroleum spirit, ether, benzol, chloroform, amyl alcohol, carbon disulphide, and cold aqueous alkalies; incompletely soluble in cold or boiling 86 per cent alcohol, 95 per cent alcohol, absolute alcohol, acetic ether, and ammonium hydrate. No change of colour was observed on treating the fixed oil with concentrated sulphuric acid, nor on the addition of syrupy phosphoric acid, though it was partially soluble in these acids. Phosphoric acid coloured it yellow; it was coloured yellowish by concentrated hydrochloric acid and nitric acid of 1·22 sp. gr. A mixture of concentrated sulphuric acid and nitric acid of 1·22 sp. gr. changed the colour of the fixed oil to a reddish brown; it was coloured pale green by sulphuric acid of 1 634 sp. gr. and of 1·53 sp. gr. Calcium disulphide gave a bright green colour reaction with the fixed oil, but did not form an emulsion with it; aqueous solutions of gold and platinum chlorides were reduced by it. The fixed oil was saponified with difficulty by alcoholic soda, but readily by boiling aqueous soda; a white fragile soap was separated and filtered from the liquid. The soap was decomposed by hydrochloric acid and the fatty acids separated. The filtrate from the soap was examined for glycerin. By the method* used an oily liquid was obtained; it was heated with anhydrous borax on platinum foil, and gave the usual green-coloured flame test for glycerin. The alcoholic solution of the *petroleum spirit residue* was fractionally precipitated with an alcoholic solution of magnesium acetate, and traces of an amorphous residue were recovered.†

The *petroleum spirit residue* was digested with water containing sulphuric acid, and examined for alkaloids, which are sometimes brought down with fixed oils. The usual reagents failed to detect traces of alkaloids.

Extract (2), *Wood of the Root.*

The maceration was carried out under the same conditions as in *extract* (1).

The *extract* was a clear colourless solution, neutral in reaction. A drop of the liquid left no uniform spot on blue paper. The *extract* was evaporated at the ordinary temperature. The *residue* was light yellow-coloured, of a semi-solid consistency, and melted at 36° C. A definite volume of the *extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Petroleum spirit residue dried at 100° C. ..	0·55 of solids.
,, ,, ,, 110° C. ..	0·35 ,,
	0·20 of loss.

The *residue* was identified as a fixed oil, associated with volatile fatty acids. The latter were indicated by the 0·2 per cent of loss and the disagreeable odour of the *residue*, which was dissipated on heating at 110° C.

* "Plant Analysis," G. Dragendorff p. 12.
† *Loc. cit.*, p. 16

The *petroleum spirit residue* from the *extract* was evaporated at the ordinary temperature, dissolved with difficulty in cold 95 per cent alcohol, and in boiling weaker alcohol; absolute alcohol hardened and discoloured it. Concentrated sulphuric acid, nitric acid, and hydrochloric acid did not appreciably act on the *residue*. It was not saponified, but slowly dissolved by boiling aqueous and alcoholic soda. The alcoholic solution of the *petroleum spirit residue* was submitted to a fractional precipitation with an alcoholic solution of magnesium acetate. The first precipitation obtained was purified by boiling alcohol; it was an opaque scaly crystalline solid which melted at 85° C. The second precipitation yielded traces of a white amorphous substance. The third precipitation resulted from adding strong ammonia water to the magnesium acetate solution, and the purified residue melted at 60° C.

Negative tests for alkaloids followed an examination of the aqueous treatment of the *petroleum spirit residue*.

Extract (3), *Green Part of the Leaf.*

The method of extraction was the same as that used in the previous extractions. The *extract* was clear pale green in colour and non-fluorescent. It was coloured by a small quantity of chlorophyll, which the petroleum spirit dissolved. The liquid was acid in reaction. A drop of it left a permanent stain on blue paper when evaporating. The *extract* was evaporated at the ordinary temperature and the *residue* was a dark greenish yellow semi-fluid substance. The solidifying point was taken. It was found to be about 15° C. A definite volume of the *petroleum spirit extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Petroleum spirit residue dried at 100° C. ..	2·20 of solids.
,, ,, ,, 110° C. ..	2·01 ,,
	0·19 of loss.

The *petroleum spirit residue* was identified as a fixed oil with a small amount of chlorophyll that had been brought into solution by it. It was soluble in cold 83 per cent alcohol, 95 per cent alcohol, absolute alcohol, amyl alcohol, ether, acetic ether, chloroform, benzol, carbon disulphide, and glycerin. It was also soluble in oil of turpentine, almond oil, ammonium hydrate, mercuric chloride, and slowly soluble in acetic acid. Concentrated nitric acid and hydrochloric acid slowly dissolved the fixed oil, the former coloured it dark green, and on stirring the mixture the colour was changed to a brown. Concentrated sulphuric acid dissolved and changed it to a very dark brown colour; on adding concentrated nitric acid the liquid was changed to a reddish brown colour.

The following reactions were noted:—The fixed oil changed to a hard greenish yellow substance on heating it with anhydrous borax on platinum foil. When rubbed on a crucible lid with powdered rosan line it was coloured red, showing the presence of free fatty acids. It did not emulsify with calcium disulphide or with syrupy antimony chloride, but it was coloured dark green by the latter. It was imperfectly dissolved by phosphoric acid, and slowly soluble in equal parts of cane-sugar and concentrated hydrochloric acid; more rapidly soluble in equal parts of cane-sugar and nitric acid. An aqueous solution of picric acid made alkaline by sodium carbonate coloured the fixed oil a light reddish brown colour, cane-sugar added to the solution facilitated dissolving it. It was instantly dissolved by equal parts of picric aid and acid ammonium phosphate, and on warming with stannous chloride, leaving a turbid yellow-coloured liquid. It was insoluble in aqueous barium hydrate; soluble in alcoholic ammonia with no colouration, and in sulphurous acid. It was coloured brown when mixed with sulphuric acid of 1·634 specific gravity, and incompletely dissolved; it was also coloured brown by ferric chloride. On adding to the fixed oil sulphuric acid of 1·475 sp. gr.

and a small quantity of zinc, hydrogen was generated, and the solubility of the oil in the acid liquid was accompanied by a rosy tint given to the solution.

Extract (4), *Yellow Part of the Leaf.*

This *extract* was obtained by a similar process as that used for the other petroleum spirit *extracts*. The *extract* was a pale yellow-coloured liquid. The reaction was slightly acid. A uniform spot was left on blue paper as the drop evaporated. The petroleum spirit was evaporated at the ordinary temperature, and a yellow-coloured *residue* recovered, of a semi-solid consistency and crystalline in structure. It solidified at 12° C. From a definite volume of the *petroleum spirit extract* the amount of total solids was determined.

Total Solids.

	Per cent.	
Petroleum spirit residue dried at 100° C. ..	1·1	of solids.
„ „ „ 110° C. ..	1·1	„
	0·00	of loss.

The *residue* was identified as a fixed oil. It was soluble in warm absolute alcohol, incompletely soluble in weaker alcohol; soluble in cold acetic ether, chloroform, benzol, amyl alcohol, ether, carbon disulphide, and glycerin. It was saponified with aqueous soda, and a white soap separated. No reaction was observed with picric acid and ammonium phosphate, nor with nitric acid of 1·32 sp. gr. and 1·18 sp. gr. The fixed oil was soluble in potassio-mercuric iodide solution, and coloured dark brown by alcoholic ammonia. A mixture of ferric chloride solution and powdered rosaniline gave a fine violet-coloured reaction with the fixed oil.

An examination of the aqueous treatment of the *petroleum spirit residues* (3) and (4) for alkaloids gave negative results. A portion of the original powder, from each of the four parts of the plant, was mixed with an aqueous solution of caustic soda, and the distillate examined for volatile alkaloids, with negative results.

(To be continued).

STUDY ON THE REACTIONS OF THE VANADATES FROM AN ANALYTICAL POINT OF VIEW.

By AD. CARNOT.

The author completes in this note his examinations of the reactions produced between the vanadates and the chief metallic salts in the ordinary conditions of analysis.

If we pour ammonia gradually into a cold acid solution containing vanadic acid, the liquid takes a more and more decided yellow colour up to the moment when it takes an alkaline reaction. This colour persists for some time if the solution remains cold. If we proceed inversely, and add acid by degrees to a colourless alkaline solution of vanadium, at the moment when it begins to redden litmus, the yellow colouration appears in full intensity, and becomes weaker on adding an excess of acid. There seems to be formed in a solution nearly neutral an acid ammonium vanadate of more colouring power than the free acid. At this moment the reactions produced by metallic salts are often different from those observed in presence of neutral vanadates. There are formed acid vanadates coloured differently from the neutral salts. To obtain the latter we may set out from an ammoniacal solution, and saturate it gradually and incompletely with an acid; or, better, operate in heat, because then the slightest excess of ammonia is sufficient to bring back the acid ammonium vanadate to the state of a neutral salt. It is advisable to determine vanadic acid by the salts of barium, manganese, or uranium, at a boil. On operating in the cold, and saturating the acid solution gradually with ammonia, we obtain with barium a yellow and less basic precipitate, whilst it is white in hot liquids. Other metallic salts present analogous instances.

Salts of Cobalt and Nickel.—A nitric solution of cobalt and of vanadic acid, exactly neutralised with ammonia in the cold so as to remain deeply yellow, soon becomes turbid, and then gives an orange-yellow deposit. The precipitation of the cobalt may become complete in the course of some hours, especially if the excess of ammonia is entirely saturated with acetic acid. The reaction is slower and more difficult if the liquid contains an ammoniacal salt other than the nitrate.

Nickel gives an analogous precipitate less readily; the precipitation is hindered by a few grammes of ammonium nitrate. In heat we obtain a pale yellow precipitate with nickel, and a brownish yellow with cobalt, but always incomplete; the presence of ammonium chloride may even prevent the appearance of any turbidity.

Salts of Zinc.—If we saturate exactly with ammonia a cold acid solution of zinc and of vanadic acid, we obtain a yellow precipitate. On heating the liquid the deposit turns white. It is very bulky, and consists of the vanadate and of other salts of zinc. There is also a white precipitate formed in the cold on mixing the neutral solution of a zinc salt with neutral colourless ammonium vanadate. It is very easily soluble in acids or in ammonia, but, on driving off by ebullition all the excess of ammonia, we obtain all the vanadic acid precipitated with an excess. We find that no vanadium remains in the decanted or filtered liquid by adding ammonium hydrosulphate, which ought to produce merely a white precipitate of zinc sulphide. Very small quantities of vanadium would colour the liquid brown and the precipitate *rose*, sometimes very bright. This rose-colour, which is permanent after washing the zinc sulphide with sulphuretted hydrogen water or pure water, seems to indicate that it is really combined with vanadium sulphide.

Salts of Cadmium.—There is formed a white precipitate in a neutral liquid; the least excess of acid or of ammonia prevents its production: it is almost always incomplete, even after prolonged boiling in presence of ammoniacal salts. Ammonium hydrosulphate yields yellow cadmium sulphide and a brown solution of sulphovanadate.

Salts of Copper.—On saturating gradually with ammonia a solution of vanadic acid and of a copper salt, there is produced in the cold a greenish yellow precipitate, which becomes a greenish brown on ignition. In heat there is formed a brownish yellow deposit, which becomes black on ignition. In both cases the precipitation of vanadium is incomplete. In presence of the same salts ammonium hydrosulphate produces a black deposit and a clear brown supernatant solution. But the deposit of copper sulphide retains a very appreciable proportion of vanadium sulphide, and the liquid contains dissolved copper. Hydrochloric acid produces in it a deposit of double sulphide of a very light rose-brown colour. It must be noted that, under the same conditions, a solution of arsenic acid and of a salt of copper, treated with ammonium hydrosulphate, yields, with the deposit of copper sulphide, a clear slightly brownish solution, which, if decomposed by hydrochloric acid, yields a yellowish orange deposit, very analogous in appearance to antimony sulphide, and consisting of copper sulpharseniate.

Mercurous Salts.—Vanadic acid may be precipitated from a nitric solution, almost exactly neutralised beforehand with ammonia by means of mercurous nitrate. The deposit formed is of an orange colour. If we add even a slight excess of ammonia there is formed a complex greyish or blackish precipitate. It may then be proved that the filtered liquid contains no vanadium. The precipitate, if gently heated in a Rose's crucible, traversed by a current of hydrogen sulphide, leaves as a residue merely vanadium sulphide. This method may, therefore,

be used for isolating or determining vanadium. The determination is made then either in the state of sulphide or of vanadic acid.

Mercuric Salts.—Mercuric chloride produces no precipitate with the vanadates, if the solution is acid; if we saturate it exactly with ammonia there is formed a light yellow precipitate; in a liquid which has been neutralised beforehand, and decolourised, the precipitate is white. The precipitation of the vanadic acid is complete, and it may be utilised, as in the former case, for the determination of vanadium.

Salts of Lead.—The mixture of lead nitrate and vanadate in a slightly acetic solution gives rise to a light yellow precipitate; in a slightly ammoniacal solution the deposit is of a yellowish white. In either case the vanadic acid may be almost entirely precipitated if the liquid is approximately neutral.

Salts of Bismuth.—Bismuth nitrate likewise forms, with a vanadate, a yellowish white liquid on saturating the liquid with ammonia. There does not remain a trace of vanadic acid in the liquid. If the liquid is slightly nitric there is produced, on boiling, an orange precipitate, generally incomplete. Boiling after the addition of sodium acetate gives a bright yellow precipitate, which may be complete. On ignition it turns orange, but becomes bright yellow again on cooling. This reaction is an additional analogy between vanadic acid and the phosphoric and arsenic acids.—*Comptes Rendus*, Vol. cv., p. 119.

TURQUOIS FROM NEW MEXICO.*

By F. W. CLARKE and J. S. DILLER.

At Los Cerillos, New Mexico, about twenty-two miles south-west of Santa Fé, are mines of turquois which have been worked for centuries. The locality has been repeatedly described,† from archæological and geological points of view; but, as far as we are able to ascertain, the turquois itself has never been fully analysed, nor has it been subjected to complete microscopic study. Having at our disposal a very full suite of specimens, collected during the summer of 1885 by J. W. Powell, Director of the U.S. Geological Survey, we have thought it desirable to investigate the subject more thoroughly, and to present our results in such form as to render them readily comparable with the published data concerning turquois from other localities.

The turquois occurs imbedded in its matrix, sometimes in nodules, oftener in seams or veins. It varies in colour very widely; ranging from a pure sky-blue, through many shades of bluish green and apple-green, to dark greens which show no blue whatever. The dark green nodules often shade off to nearly white at the centre, sometimes resembling in structure, as Blake has observed, certain varieties of malachite. Many of the specimens are seamed or streaked by limonite, which has been derived from accompanying pyrite; and the latter mineral occasionally is found, bright and unaltered, enclosed completely in masses of clear blue turquois.

For analysis, three samples of turquois were selected, representing as nearly as possible the most definite types of the mineral. They may be summarily described, as follows:—

A. Bright blue, faintly translucent in thin splinters.

B. Pale blue, with a slight greenish cast, opaque and earthly in lustre, and of sp. gr. 2·805. Blake gives the density from 2·426 to 2·651 for the green variety.

C. Dark green, opaque.

	A.	B.	C.
H_2O	19·80	19·60	18·49
Al_2O_3	} 39·53	36·88	37·88
Fe_2O_3		2·40	4·07
P_2O_5	31·96	32·86	28·63
CuO	6·30	7·51	6·56
SiO_2	1·15	0·16	4·20
CaO	0·13	0·38	undet.
	98·87	99·79	99 83

Analysis "A" is not quite complete, for enough material could not be obtained without the destruction of too valuable specimens. The silica in it was due to traces of admixed rock from which the material could not well be perfectly freed. "C," however, was free from rock; and the silica in it must be accounted for otherwise. Silliman reports the turquois as containing 3·81 of copper, which corresponds to 4·78 of CuO; but he gives no other quantitative data.

In attempting to discuss these results it will be well to compare them with two other published analyses of turquois from different localities. First, we have the figures given by Church* for the well known variety from Persia; and secondly, the analysis by G. E. Moore† of turquois, pseudomorphous after apatite, from Taylor's Ranch, Fresno County, California.

	Persia	California.
H_2O	19·34	19·98
Al_2O_3	40·19	35·98
Fe_2O_3		2·99
FeO	2·21	
P_2O_5	32·86	33·21
CuO	5·27	7·80
MnO	0·36	
	100·23	99·96
Sp. gr.	2·75	2·798, 2·815

These analyses, leaving temporarily out of account that of the dark-green variety, agree well with each other in their atomic ratios. Dividing the percentages by the proper molecular weights, and treating the bases together, the following ratios appear.

	Total base.	P_2O_5.	H_2O.
New Mexico, A ..	0·468	0·225	1·100
New Mexico, B ..	0·479	0·231	1·089
Persia	0·492	0·231	1·075
California	0·470	0·234	1·110

In each case the base stands to the acid in a ratio very slightly in excess of two to one; and that excess may fairly be accounted for upon the supposition that it represents a trifling admixture of limonite. The water is present in a proportion a little under that of five molecules to one of phosphoric acid, the variation here being due to the differences in the percentages of copper. If we calculate the amount of phosphoric acid necessary to satisfy the alumina, and then reckon the phosphate so obtained as requiring five molecules of water, we shall have left over a quantity of copper, acid, and water corresponding to a very simple formula; and the turquois will appear as a variable mixture of the two following salts:—

$$2Al_2O_3.P_2O_5.5H_2O.$$
$$2CuO.P_2O_5.4H_2O.$$

In the Californian turquois the analytical results fit these formulæ quite sharply, and give the ratio between the two compounds as approximately four to one. The first formula may be regarded as that of normal turquois, and may be written in rational form, halved, as

$$Al_2HPO_4(OH)_4.$$

* From the *American Journal of Science*, vol. xxxii.

† W. P. Blake, *American Journal of Science*, II., xxv., 227, 1858. J. S. Newberry, "Report of the Exploring Expedition from Santa Fé to the Colorado," &c., 1859; printed, 1876. B. Silliman, *American Journal of Science*, III., xxii., 67, 1881.

* Chemical News, x., 290. Dana's "Mineralogy," p. 581.

† V. von Zepharovich and G. E. Moore. *Zeitsch. für Kryst. u. Min.*, x., 240.

The copper salt, to which the mineral owes its colour, is to be considered merely as an impurity; a view which is emphasized by the analysis of the dark-green turquois, "C." In the latter case the same ratios apply, modified by the presence of silica, which is nearly sufficient to form with the copper a normal metasilicate, similar to if not identical with chrysocolla. This silicate, with whatever blue tinge of colour it might have, affected by the yellow or brown of the iron present, probably gives the turquois its green hue. It is exceedingly probable that the purity of tint in gem turquois is due to the copper salt alone; and that degradations of the colour towards green are ascribable to admixture of salts of iron. It is noteworthy that, of the three turquoises analysed, the bluish contains the lowest percentage of copper. This could hardly be the case were not the colours of the other samples modified by some impurities; and compounds of iron would naturally produce an effect in the observed direction.

Sections of the three varieties of turquois were studied under the microscope, and found to be of essentially the same character. Although deeply coloured in the hand specimens, the thin sections appeared almost clear and transparent. Between crossed nicols the deep blue and green forms were seen to be composed of minute grains, or short, thick fibres; but in the paler varieties the fibrous structure was more pronounced. The optical properties of both grains and fibres are the same throughout. They are all weakly doubly refracting, but have a rather high refractive index. The finely granular portions have a pale bluish aggregate polarisation, less intense than that of chlorite; but when the mineral is distinctly fibrous it polarises like some forms of serpentine, with light colours of the first order. The fibres are generally somewhat bent and interwoven, but lie approximately in the same direction. Each fibre becomes dark when parallel to the principal section of either of the crossed nicols, indicating that they must crystallise according to either the quadratic, hexagonal, or rhombic system, instead of in one of the inclined systems, as was the case with the fibres studied by Bücking* in the turquois of Fresno County, California.

A section was prepared of a distinct vein of pale green turquois, which showed that the fibrous structure is directly across the vein perpendicularly to its walls. Small fissures, running into or across the veins, have the fibres of turquois arranged perpendicularly along their sides, just as serpentine arranges itself along fissures in olivine. Sometimes the fissures are minute and curved; but the resulting arrangement does not simulate the radial fibrous or spherulitic structure described by Bücking† as found in the turquois of California, Nevada, and elsewhere.

The perpendicular arrangement of the turquois fibres along fissures crossing the vein, indicates that the mineral may have been derived from the alteration of another substance with which the vein was formerly filled. We would suppose, of course, that the original vein material was itself a phosphate; and the only one after which turquois is known to be pseudomorphous is apatite; a species which not infrequently occurs in veins. The opinion that the turquois has resulted from such an alteration is favoured by the presence of other alteration products, to be noted in considering the composition of the country rock in which the turquois it found. It is also suggested by Hermann's analysis of blue oriental turquois, in which the equivalent of 3·41 per cent of calcium phosphate was actually determined.‡

The rock in which the veins of turquois occur is described by Blake as "a granular porphyry, yellowish, grey, or white in colour, porous and earthy in texture. It decomposes rapidly by weathering, and very much resembles a sandstone." In the collection made by Major Powell there are several good examples of the rock penetrated by the turquois. It is a fine grained, reddish, felspathic rock, mostly fresher than that described by Blake, and it has a microgranitic aspect. It contains numerous particles of biotite and pyrite, with stainings of oxide of iron. The hand specimens look as though they had been crushed, and the fissures thus formed so filled as to produce irregular veins and nodules. The veins are small, and mostly composed of turquois, in which are imbedded a few scales of biotite, particles of pyrite, and considerable quartz and oxide of iron. Scales of biotite are found abundantly in the iron-stained cavities, as well as in the solid portions of the rock. Some specimens of rock, containing much pale blue turquois of earthy texture, have been completely kaolinised, and a partial analysis of the kaolin gave the following results:—

H_2O	12·88
SiO_2	52·38
$Al_2O_3 + Fe_2O_3$	33·49
P_2O_5	none
MgO	1·17
CaO	trace
	99·92

Although the mineral itself was white, the alumina from it was distinctly reddish with the iron.

Under the microscope the rock is seen to be composed chiefly of felspar, with a considerable amount of biotite, epidote, pyrite and limonite, and some amorphous substance. It is somewhat microgranitic in structure, and the irregular, interlocking grains of felspar vary in size from 0·01 to 0·8 m.m. in diameter. Most of them are consideraby kaolinised, so as to appear cloudy in ordinary light; but between crossed nicols the original outlines of the grains become more distinct. Their optical properties indicate that the felspar is orthoclase; an opinion which is fully borne out by the subjoined analysis of the rock, which shows a remarkably large proportion of potash.

H_2O	3·28
SiO_2	56·68
Al_2O_3	16·62
Fe_2O_3	6·50
P_2O_5	0·73
MgO	0·79
CaO	0·59
CuO	trace, undet.
MnO	1·02
FeS_2	2·21
K_2O	11·18
Na_2O	1·03
	100·63

The porphyritic crystals are generally Carlsbad twins with irregular outlines. There are occasionally small grains of fresh, transparent plagioclase, which has evidently resulted from alteration.

The biotite of the rock occurs in noteworthy quantities, but is very unequally distributed. It is frequently aggregated in groups of scales, and may be seen most abundantly in small cavities. It sometimes occurs intimately associated with the turquois, but unlike the latter it is one of the primary minerals. The small quantity of quartz present is a secondary product, so intimately associated with turquois as to suggest their genetic connection. Pyrite is scattered rather uniformly throughout the rock in small cubical crystals easily seen in the hand specimen. They are sometimes altered to limonite, but in other cases they have been completely replaced by pseudomorphs of epidote. The specimen of rock which was subjected to analysis probably contained an amount of pyrite rather greater than the average.

One of the most important constituents of the rock, because of its very close association with the turquois, occurs in the form of bright yellow grains. They are not distinctly pleochroic, but have a high refractive index, with strong double refraction, and give brilliant aggregate

* See paper by v. Zepharovich and Moore, previously cited.
† *Zeitsch für Kryst. und Min.*, ii., p. 103.
‡ See Dana's "System of Mineralogy," p. 581.

polarisation. The particles are usually very small, and grouped together in irregular compound grains so as to suggest nothing of crystallographic form. In several cases, however, elongated simple grains show inclined extinction; which indicates that the mineral must be either monoclinic or triclinic in crystallisation. Judging not only from the properties enumerated, but also from the percentage of lime in the rock, this mineral is in all probability epidote. It is evidently connected genetically with the turquois, for it is almost uniformly found upon the border of the latter, and is most abundant in its neighbourhood.

Concerning the origin of the turquois bearing-rock, it may be stated that Professors Newberry and Silliman, both of whom studied it in the field, regard it as eruptive, and probably of Tertiary age. The occurrence of this veritable orthoclase rock in the West is of special interest from the facts disclosed by recent investigations that in many of the rocks previously described as trachytes the predominating felspar is plagioclase.

The very small size of the veins and their limited distribution show that the turquois is of local origin, and emphasizes the idea that it has resulted from the alteration of some other mineral. In addition to the evidence already cited to show that the turquois has been derived from apatite, we have the fact that epidote, a lime-bearing mineral, is present as a secondary product. The oxidation of pyrite may have had something to do with initiating the process of alteration, and the alumina of the turquois was probably derived from decomposing felspar. The latter suggestion was made by Silliman, who also examined microscopic sections of the rock, and reported apatite as present. No apatite, however, could be seen in the specimens examined by us. A search for it at the locality would certainly seem to be desirable.

TYROTOXICON: ITS PRESENCE IN POISONOUS CHEESE, ICE-CREAM, AND MILK.*

By VICTOR C. VAUGHAN.

Poisonous Cheese.

Historical.—The learned poet and chemist, Justinus Kerner, first made experimental investigations concerning the nature of certain foods which become poisonous by fermentation, or more properly by putrefaction. Kerner's first work was published in 1817.† This was devoted to poisonous sausage, and in this work we find that the author concluded that the poisonous principle consisted of a fatty acid analogous to the sebacic acid of Thenard. Later, Kerner modified this opinion, and announced his belief that the poisonous substance consisted of a fatty acid combined with a volatile base.‡ Dann, following Kerner, believed the active principle of poisonous sausage to be an acrid, empyreumatic oil, which when pure is not poisonous, but is rendered so by combination with fatty acids.§ Buchner describes a botulinic acid which he conceived to be the active agent. Other observers also attributed the poisonous effects to fatty acids.

These statements in regard to poisonous sausage have been made on account of the similarity of the effects of poisonous sausage and poisonous cheese, and to call attention to the general belief of the older investigators that the active agent was in some way intimately connected with the fatty acids.

In 1827 Professor Hünnefeld made some analyses of poisonous cheese, and experimented with extracts upon the lower animals.* He accepted the ideas of Kerner in a somewhat modified form, and thought the active agents to be caseic and sebacic acids. About the same time Sertürner, making some analyses of poisonous cheese for Dr. Westrumb, also traced the active agents, as he supposed, to sebacic and caseic acids.† We see from the above that during the first part of the present century the fatty acid theory, as we now call it, was generally accepted.

In 1844 Dr. Christison, after referring to the work of Hünnefeld and Sertürner, makes the following statement: —"His (Hünnefeld's) experiments, however, are not quite conclusive of the fact that these fatty acids are really the poisonous principles, as he has not extended his experimental researches to the caseic and sebacic acids prepared in the ordinary way. His views will probably be altered and simplified if future experiments should confirm the late inquiries of Braconot, who has stated that Proust's caseic acid is a modification of the acetic cambined with an acrid oil."‡

In 1852 Schlossbergerger made experiments with the pure fatty acids, and demonstrated their freedom from poisonous properties.§ These experiments have been verified repeatedly, so that now it is well known that all the fatty acids obtainable from cheese are devoid ot poisonous properties.

It may be remarked here that there is every probability that the poisonous substance was present in the extracts obtained by the older chemists. Indeed we may say that this is a certainty, since the administration of these extracts to cats was—in some instances at least—followed by fatal results. The great mass of these extracts consisted of fatty acids, and as the chemists could find nothing else present they very naturally concluded that the fatty acids themselves constituted the poisonous substance.

Since the overthrow of the fatty acid theory, various other conjectures have been given, but none of them are worthy of credit.

We make the following quotations from some of the best recent authorities on the subject to show their opinions:—

"Nothing definite is known of the nature of cheese poison. Its solubility seems established from an observation of Hussemann,—a case in which the poison was transmitted from a nursing mother to her child." ‖

"The older investigations of the chemical nature of cheese poison, which led to the belief of 'putrefactive cheese acids' and other problematic substances, are void of all trustworthiness, and the discovery of the active principles of poisonous cheese may not be looked for in the near future, on account of proper animals for controlling the experiments with the extracts, as dogs can eat large quantities of poisonous cheese without its producing any effect."¶

"All kinds of conjectures concerning the nature of this poison have been formed, but all are even devoid of historical interest, because they are not based upon experimental investigations. My own experiments towards solving this question have not progressed very far." **

Other authorities might be cited, but all state substantially the same thing.

History of the Michigan Cases.—In the years 1883 and '84 there were reported to the Michigan State Board of Health about 300 cases of cheese poisoning. As a rule

* Read before the Chemical Section of the American Association for the Advancement of Science, August, 1886.

† "Dass Fettgift oder die Fettsaeure und ihre Wirkungen auf dem Thierischen Organismus," &c. Stuttgart und Tubingen, 1817. Hiller gives the date of Kerner's first paper as 1782, but Kerner was not born until 1786.

‡ "Die Neuste Vergiftungen durch Verdorbene Wuerste," &c. Carlsruhe, 1821.

§ *Horn's Archiv.*, 1828, B. 1, S. 596.

* *Horn's Archiv.* B. 1, S. 203.

† *Ibid.*, B. 1, S. 65.

‡ "A Treatise on Poisons." First American from the fourth Edinburgh edition, p. 496.

§ *Archiv f. Physiologische Heilkunde*, 1853.

‖ Dr. Arnold Hiller, "Die Lehre der Faulniss." Berlin, 1879 S. 197.

¶ Hussemann, "Real-Encyclopedia der gesamten Heilkunde," 1881 B. VI., S. 313.

** Brieger, "Ueber die Ptomaine," 1885, S. 50.

the first symptoms appeared within from two to four hours after eating of the cheese. In a few the symptoms were delayed from eight to ten hours, and were very slight. The attending physicians reported that the gravity of the symptoms varied with the amount of cheese eaten, but no one who ate of the poisonous cheese wholly escaped.

One physician reported the following symptoms:—"Every one who ate of the cheese was taken with vomiting; at first of a thin, watery, later a more consistent reddish-coloured substance. At the same time the patients suffered from diarrhœa with watery stools. Some complained of pain in the region of the stomach. At first the tongue was white, but later it became red and dry, pulse was feeble and irregular; countenance pale, with marked cyanosis. One small boy, whose condition seemed very critical, was covered all over his body with bluish spots.

Dryness and constrictions of the throat were complained of by all. In a few cases the nausea and diarrhœa were followed by marked nervous prostration.

Notwithstanding the severity of the symptoms in many, there was no fatal termination. Many of the physicians at first diagnosed the cases from the symptoms as due to arsenical poisoning, and administered ferric hydrate. Others gave alcohol and other stimulants, and treated upon the expectant plan.

The Poisonous Cheese.—All of these 300 cases were caused by eating of twelve different cheeses. Of these nine were made at one factory, and one each at three other factories. Of each of the twelve I received smaller or larger pieces. Of each of ten I received only small amounts. Of each of the other two I received about 18 kilos. The cheese was in good condition, and there was nothing in the taste or odour to excite suspicion. However, from a freshly cut surface there exuded numerous drops of a slightly opalescent fluid, which reddened litmus instantly and intensely. (Although, as I have stated, I could discern nothing peculiar in the odour, if two samples—one of the good, the other of poisonous cheese—were placed before a dog or cat, the animal would invariably select the good cheese. But if only poisonous cheese was offered, and the animal was hungry, it would partake freely.) A cat was kept seven days and furnished only with poisonous cheese and water. It ate freely of the cheese and manifested no untoward symptoms. After the seven days the animal was etherised, and abdominal section was made. Nothing abnormal was discovered. I predicted, however, in my article on poisonous cheese,* that the isolated poison would affect the lower animals. As to the truth of this prediction we will see later.

My friend Dr. Sternberg, the eminent bacteriologist, found in the opalescent drops, above referred to, numerous micrococci. Inoculation of rabbits with these failed to produce any results.

Extracting the Poison.—At first I made an alcoholic extract of the cheese. After the alcohol was evaporated *in vacuo*, at a low temperature, a residue consisting mainly of fatty acids remained. I ate a small bit of this residue, and found that it produced dryness of the throat, nausea, vomiting, and diarrhœa. For some weeks I endeavoured to extract the poison from these fatty acids, but all attempts were unsuccessful. I then made an aqueous extract of the cheese, filtered this, and, drinking some of it, found that it also was poisonous. But after evaporating the aqueous extract at 100° on the water-bath, this residue was not poisonous. From this I ascertained that the poison was volatile at or below the boiling-point of water. I then tried distillation at a low temperature, but by this the poison seemed to be decomposed.

Finally, I made the clear, filtered aqueous extract, which was highly acid, slightly alkaline with sodium hydrate, agitated this with ether, removed the ether, and allowed it to evaporate spontaneously. The residue was highly poisonous. By re-solution in water and extraction with ether the poison was separated from foreign substances. As the ether took up some water this residue consisted of an aqueous solution of the poison. After this was allowed to stand for some hours *in vacuo* over sulphuric acid, the poison separated in needle-shaped crystals. From some samples the poison crystallised from the first evaporation of the ether and without standing *in vacuo*. This happened only when the cheese contained comparatively a large amount of the poison. Ordinarily the use of the microscope was necessary to detect the crystalline shape. From 16 kilos. of one cheese I obtained about 0·5 grm. of the poison, and in this case the individual crystals were plainly visible to the unaided eye. From the same amount of another cheese I obtained only about 0·1 grm., and the crystals in this case were not so large. I have no idea, however, that by the method used all the poison was separated from the cheese.

Properties of the Poison.—I have called this poison tyrotoxicon (cheese poison). It gives, with potassium ferricyanide and ferric chloride, Prussian blue. It also reduces iodic acid. However, I do not consider either of these reactions characteristic, and a number of other substances will also give them. Peptones, a small amount of which is present in all milk, will give these reactions. The ordinary alkaloidal reagents failed to produce any precipitate with tyrotoxicon. The crystals have a penetrating old-cheesy odour, and it is interesting in this connection to state that Hussemann and Bœhm have both observed this odour in poisonous sausage. If the crystals be allowed to stand exposed to the air, at ordinary temperature, they decompose with the formation of an organic acid whose nature has not been determined. Tyrotoxicon is soluble in water, alcohol, chloroform, and ether. I am sorry that I have not been able to obtain this substance in quantities sufficient for an ultimate analysis. But the smallness of the amounts obtained and the rapid decomposition of the poison has prevented any such analysis.

The physiological test for the poison I regard as the only certain one. A few drops of an aqueous solution of these crystals placed upon the tongue produced the symptoms already described as characteristic of poisonous cheese. This was tried repeatedly upon myself and upon some of my students who kindly offered themselves for experimentation.

The Poison in Milk.

In November, 1885, a student brought to me a 4-ounce bottle partly filled with milk which had stood tightly closed with a glass stopper for about six months. From this I succeeded in isolating the same poison. It was recognised by its crystalline appearance and by its effect upon myself. It was presumed that this milk was normal in composition when first obtained; but of this we could not be certain.

I then put several gallons of normal milk in perfectly clean bottles with glass stoppers, and allowed these to stand in my work room. From time to time a bottle was opened, and the test for tyrotoxicon was made. These tests were followed by negative results, until about three months after the experiment was begun. I then succeeded in getting the poison from one of the bottles. The method for testing for it was as follows:—The coagulated milk was filtered through heavy Swedish filter-paper. The filtrate was colourless and decidedly acid in reaction. It was rendered feebly alkaline by the addition of potassium hydrate, then agitated with ether. After separation the ethereal layer was removed with a pipette, allowed to run through a dry filter-paper to remove a flocculent white substance which floated in it, and then allowed to evaporate spontaneously. If necessary this residue was dissolved in water and again extracted with ether. On the evaporation of the ether the tyrotoxicon was recognised by its crystalline appearance, by its odour, and by

* "Ein Ptomain aus giftigem Kase." *Zeitschrift fur Physiol. Chemie*, B. x., S. 146.

placing a small bit on the tongue. As the ether takes up some water, there is usually enough of the latter left after the spontaneous evaporation of the ether to hold the poison in solution, and in order to obtain the crystals this aqueous solution must be allowed to stand for some hours *in vacuo* over sulphuric acid.

From one-half gallon of milk there was obtained quite a concentrated aqueous solution of the poison after the spontaneous evaporation of the ether. Ten drops of this solution placed in the mouth of a small dog, thret weeks old, caused, within a few minutes, frothing at the mouth, retching, the vomiting of frothy fluid, muscular spasm over the abdomen, and after some hours watery stools. The next day the dog seemed to have partially recovered, but was unable to retain any food. This condition continuing for two or three days, the animal was killed with chloroform. No examination of the stomach was made.

It may be remarked here that I have elsewhere pointed out the necessity of using pure ether for these extractions, as some samples of ether contain an irritating ptomaine-like substance.

(To be continued.)

CORRESPONDENCE

ESTIMATION OF THEINE.

To the Editor of the Chemical News.

Sir,—I observe that in a recent contribution to the *Farmatzevtitchesky Jurnal* (No. 12, 1887, p. 177), Prof. Loesch, of St. Petersburgh, has given an account of a process for the estimation of theine in tea, consisting in the extraction of the tea-leaves with boiling water, evaporation of the infusion on a water-bath after addition of magnesia, and extraction of the residue with chloroform.

This process, as many other chemists who, besides myself, must have used it can no doubt testify, is an excellent one, but it is certainly not new. I have employed it for the past six years (with the modification of extracting the tea-leaves in a flask provided with a vertical Liebig's condenser), and like it better than any other process for the determination of theine. It answers, of course, equally well in the analysis of coffee.—I am &c.,

E. Godwin Clayton, F.C.S., F.I.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Seances, de l'Académie des Sciences. Vol. civ., No. 26, June 27, 1887.

Determination of the Quantity of Potassium Disulphate in a Dilute Liquid.—E. Bouty.—If we wish to apply the measure of conductivities to the absolute determination of the quantity of potassium disulphate in a dilute liquid, we are confronted by a first difficulty; we cannot determine the conductivity of the pure disulphate, this salt being always accompanied, in dilute solutions, by sulphuric acid and potassium sulphate. Still we may, without a notable error, confound the conductivities of the acid and the neutral sulphate. Potassium disulphate is especially stable in hot and concentrated liquids. An excess of neutral sulphate is more favourable than an excess of acid.

Decomposition of Hyposulphites by Acids.—G. Foussereau.—If we operate on a mixture containing, per litre, 1-12th equivalent of the two reagents, and capable of becoming turbid at once, the electric resistance increases at first very rapidly, then more and more slowly, reaching, after about ten days, a limit equal to $\frac{3}{2}$ of the primitive resistance. The decomposition of the hyposulphurous acid is therefore completed progressively. If we operate upon very dilute mixtures containing from 1-1000th to 1-2000th equivalent per litre, the increase of resistance begins at once, but very slowly. It quickens progressively during the first days, attains a maximum speed after about forty days, then slackens and ceases. The final resistance is again about $\frac{3}{2}$ of the original resistance.

On Ammonium Vanadates.—A. Ditte.—A general study of the vanadates, whether prepared in the moist or the dry way, shows that they belong to the following definite types:—$3VO_5MO$; $2VO_5MO$, $3VO_5,2MO$ for the acid salts; VO_5MO for the neutral compounds, and VO_52MO, VO_53MO, VO_54MO, for the basic salts. The author has not met with the formula $5VO_53MO$, ascribed to certain salts by some authors.

Solubility of Uric Acid in Water.—MM. Blarez and G. Denigès.—One hundred grms. of water dissolve 2 m.grms. of uric acid at 0°, and 62·5 at 100°.

On Ferric Chloride Hydrochlorate.—Paul Sabatier.—The author has obtained this compound by exactly the same process as far back as 1881 (*Bulletin de la Société Chimique*, 2nd series, p. 197).

Study of the Reactions of the Vanadiates from an Analytical Point of View.—A. Carnot.—(See p. 42).

The Identity of Dambose and of Inosite.—M. Maquenne.—Dambose is strictly identical with the inosite of leaves or of muscles, and dambonite should be considered as the dimethyline of inosite. The term dambose ought to be expunged from chemical nomenclature.

On Mono-nitro-acenaphthene.—E. Jandrier.—This compound is formed on adding, drop by drop, nitric acid of 1·34 sp. gr., to a hot saturated solution of acenaphthene in glacial acetic acid. It crystallises from alcohol, ether, or acetic acid in white silky tufts, fusible at 155°.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., April, 1887.

Researches on Titanium.—Otto von der Pfordten.—This voluminous treatise is taken from the last year's volume of *Liebig's Annalen*.

Purification of Water.—W. Anderson.—From the *Journal of the Society of Arts*.

Analysis of Opium.—Charles Stillwell.—From the *American Chemical Journal*.

Redondite and its Value for the Manufacture of Phosphates.—Walter Tate.—Taken from the *Journal of the Society of Chemical Industry*.

Measurement of the Rotatory Powers of Quartz.—Dr. G. Quesneville.—The author gives his results in the form of tables.

Manufacture of Strontium Hydroxide.—E. F. Trachsel.—From the *Journal of the Society of Chemical Industry*.

Industrial Preparation of Resorcine.—Dr. Otto Mühlhaüser.—For the industrial preparation of resorcine we melt sodium benzol-disulphonate with sodium hydroxide, thus obtaining sodium resorcinate, which is then decomposed with an acid, and the resorcine is extracted from its aqueous solution by means of ether or amylic alcohol. The product is then purified by distillation under a reduced pressure. The preparation of resorcine from benzol includes, therefore, the following operations:—Preparation of benzol-monosulphonic acid and then of the disulphonic acid; preparation of resorcine by fusion, decomposition of the sodium salt, extraction, and purification. The final yield is 19 to 23 kilos. of pure resorcine from 125 kilos. sodium benzol-disulphonate.

Industrial Society of Mulhouse. Session of the Chemical Committee, January 12, 1887.—The secretary presented a sealed paper (No. 382, Oct. 27, 1883), deposited by R. Geigy, of Bâle, and opened at the general session of Jan. 26, 1887. It refers to a yellow colouring-matter discovered by Dr. J. Walter, chemist to the firm of Geigy and Co., and subsequently introduced into commerce as "solar yellow." The colour is obtained by the action of hot strong alkaline solutions upon para-nitro-cresyl-ortho-sulphonic acid. It dyes cotton a fine orange yellow without mordants. M. Casanovas sent in, through M. Noelting, a paper on white, blue, yellow, green, and black discharges on Congo reds, thus imitating the Turkey-red discharge styles. The principle of the method consists in reducing and discharging the Congo with stannous acetate, to which is added prussiate for blues, berry-liquor for yellows, and reduced logwood for blacks.

On Phenazine, the Initial Material of Toluylene Red, and of the Saffranines.—V. Merz and Bernthsen.—On heating orth-toluylene-diamine with pyrocatechine Merz obtained methyl-phenazine. The same compound was obtained by Bernthsen and Schweitzer by the decomposition of a colouring-matter belonging to the group of toluylene reds. Toluylene red, which is formed by the reaction of nitroso-dimethyl-aniline upon meta-toluylene diamine and oxidising the toluylene blue (indamine) thus obtained, contains an amidic group which may be removed by means of nitrous acid. The resulting product is very analogous to Witt's colour, *eurhodine*, prepared by the reaction of ortho-amido-azo-toluene upon α-naphthylamine, and belonging to the group of the quinoxalines. On diazotising this substance we obtain a compound, $C_{15}H_{15}N_3$, in fine needles or prisms of a garnet-red colour with a green reflection. It is distinctly basic, dissolves in dilute acids with a violet colour and in strong sulphuric acid with a red brown colour, which, on dilution, passes to a green, a blue, and finally to a violet with a fine golden-yellow fluorescence. It is to be regarded as dimethyl-amido-methyl-phenazine.

Nickel as Material for Capsules and Crucibles.—J. A. Wanklyn.

Laboratory Utensils of Nickel.—Bertram Blount.

Laboratory Utensils of Nickel.—T. Bruce Warren.

Laboratory Utensils of Nickel.—T. Tarrington.

Nickel Crucibles.—J. Dagger.

Detection of Impurity of Nickel and other Metals by Means of the Magnet.— T. Bruce Warren.— These papers are all from the CHEMICAL NEWS.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxix., Part 1.

Delicacy of the Sense of Smell.—E. Fischer and Fr. Penzoldt.—The only trustworthy determinations of the quantities of substances necessary to excite the sense of smell have been hitherto carried out by Valentin. He found that the quantities thus capable of recognition were $\frac{1}{300}$ m.g. bromine, $\frac{1}{3000}$ hydrogen sulphide, and $\frac{1}{30000}$ oil of roses. The authors have undertaken analogous experiments with other strongly smelling substances, and have arrived at still smaller values. For the experiments they used an empty room containing 230 cubic metres, with painted walls and a stone floor. Of the substance to be examined 1 grm. was weighed out, dissolved in 1 litre of pure alcohol, and 5 c.c. of this solution were again diluted with alcohol in known proportions. Of this last mixture from 1 to 3 c.c. were measured into a small flask closed with a cork provided with two bent glass tubes. The weighing, diluting, and measuring the odoriferous substance was carried on in the laboratory far distant from the room, and by a person not engaged in the experiment. For the experiment the contents of the flask were evaporated by one of the authors by means of a small hand-blast, all openings of the room having been first closed, which required from five to ten minutes, and the air of the room was then very carefully mixed and agitated for ten minutes by means of a large flag. At a signal the other author entered to test the odour. The result was further checked by an independent observer. In one of the experiments the quantity of merceptan evaporated was 0·01 m.g. This was faintly but distinctly recognised. The proportion of mercaptan to the air was in round numbers 1 : 50,000,000,000, and the quantity which could come in contact with the olfactory nerves was 1·460,000,000th m.g. This quantity is 250 times smaller than the quantity of sodium detected spectroscopically by Kirchhoff and Bunsen. Hence merceptan may be utilised in experiments on currents of air, the diffusion of gases, the efficacy of arrangements for ventilation.

MISCELLANEOUS.

The Cheshire Alkali Company, Limited. — We beg to direct the attention of our readers to the prospectus of this company which appears in our advertising pages. From all the information before us we should judge that the new undertaking has an excellent chance of success. The value of Dr. Pick's system has been already proved on the large scale in Austria. The estimate of 20 per cent returns on the capital to be subscribed will not appear extravagant if we remember that Brunner, Mond, and Co., Limited, for whom Dr. Pick was manager, have been paying 35 per cent per annum, in addition to carrying large sums to reserve. The new company will have the exclusive right of patenting Dr. Pick's improvements in any country except Austria and Germany.

Dr. A. W. Williamson.—We have received a circular bearing the signatures of Sir Henry Roscoe, Professor Odling, Professor Michael Foster, Professor G. C. Foster, Dr. Gladstone, and several other well known men of science, who have either been pupils of A. W. Williamson during the thirty-eight years that he has been Professor of Chemistry in University College, London, or have been otherwise intimately associated with him. In this circular it is suggested that Professor Williamson's resignation of his Chair affords a fitting opportunity for recording in some permanent manner the high appreciation of his influence as a scientific teacher and the feeling of personal regard for him as a man which are so generally entertained by those who know his work and character. It is accordingly proposed to ask him to sit for a portrait to be presented to University College, and subscriptions are invited for this purpose. As it is expected that the proposal will be widely responded to, one guinea is suggested as the ordinary amount of a subscription. Dr. W. J. Russell, F.R.S., 34, Upper Hamilton Terrace, N.W., has agreed to act as Honorary Treasurer of the fund to be collected, and Michael Carteighe, Esq., 36, Nottingham Place, W., and Dr. H. Forster Morley, University Hall, Gordon Square, W.C., have consented to be Honorary Secretaries.

TO CORRESPONDENTS.

B.P.S.—"The Methods of Glass-Blowing," by W. A. Shenstone.

A. Crosbie.—"Watts's Dictionary of Chemistry" is by far the best work of the kind in the English language.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.
FRANKLIN BARROW,
CLAYTON
Near MANCHESTER.

THE CHEMICAL NEWS.

VOL. LVI. No. 1445.

THE ESTIMATION OF SILICON IN IRON AND STEEL.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S., F.I.C.
Lecturer on Metallurgy, Mason College, Birmingham.

ABOUT three years ago the author published some observations on the estimation of silicon in iron and steel (*Jour. Chem. Soc.*, 1884, p. 260). In this paper a number of comparisons were made of the relative accuracy of certain methods of analysis commonly recommended; since that time several other methods have been tried, and some results recently obtained in the metallurgical laboratory appear to be of sufficient interest to bring before this Society.

It is customary in some ironworks in this country to estimate silicon in pig-iron by heating the sample with dilute sulphuric acid and evaporating to dryness; the residue is extracted with boiling water, and the insoluble portion, after treatment with hydrochloric acid, is carefully washed, ignited, and weighed. This method is recommended in "Mitchell's Assaying" (5th edit., p. 363) and other text-books; it possesses some advantages which recommend it in certain cases, as the solution and evaporation are easily performed, while the siliceous residue obtained is frequently as white as snow. It will be shown, however, that in some cases the method is apt to be misleading, and that the whiteness of the residue is no guarantee of its purity. In my own analyses by this method the procedure is as follows:—For a sample of cast-iron, 2 grms. of metal in the form of borings are placed in a clean beaker of about 8 ozs. capacity and covered with about 50 c.c. of water, 5 c.c. of sulphuric acid are then added, and the beaker kept covered while solution proceeds. The liquid is then evaporated till quite solid, after which it is extracted with 100 c.c. of boiling water. The insoluble portion is washed with boiling hydrochloric or nitric acid, and afterwards with water so long as any iron is extracted. It is necessary in all cases to test the filtrate by potassium ferrocyanide or theiocyanate. The insoluble portion is dried, ignited, and weighed in the usual way.

In the analysis of steels containing only a small quantity of silicon, results by this method agree fairly well with those obtained by other trustworthy processes. In pig-iron of specially good quality good results are also obtained, of which some examples may be given.

No. 3 *Hæmatite Pig.*—This sample had been examined by my friend Mr. J. P. Walton, of the Glasgow Iron Co., Wishaw, who obtained:—Silicon, 2·70 per cent; phosphorus, 0·04 per cent. Four determinations by students in the metallurgical laboratory gave respectively 2·61, 2·70, 2·75, and 2·78 per cent of silicon, the mean result being 2·71 per cent. Mr. C. H. New, by the sulphuric acid process, obtained 2·71 and 2·68 per cent, the mean being 2·695. The result of the whole analyses may be arranged thus:—

Mr. J. P. Walton	2·70 per cent.
Laboratory determinations	2·71 ,,
Sulphuric acid process	2·695 ,,

and it will be seen that the agreement is very satisfactory.

Lilleshall Cold Blast Pig.—This specimen I had previously examined by several methods, and obtained the following values (*Jour. Chem. Soc.*, 1884, p. 265):—

	Per cent SiO_2.
By treatment with HCl without evaporation	2·37
,, ,, ,, ,, and evaporation	2·52
,, ,, ,, ,, evaporation, and fusion	2·58
,, ,, ,, $HCl + HNO_3$ and evaporation	2·45
By treatment with $HNO_3 + H_2SO_4$ (Drown's method)	2·42
By combustion in chlorine	2·46

In each case the values are for silica (SiO_2) calculated as percentage on the original metal; probably the correct amount is 2·46 per cent. The sulphuric acid method gave 2·455 per cent of silica, a very close agreement.

In the previous cases a very superior class of pig was being examined, and under such circumstances the process gives every satisfaction. But unfortunately the majority of iron is less pure than the above mentioned, especially with regard to the amount of phosphorus present, and with such metal the method under consideration is very liable to be untrustworthy.

No. 4 *Northampton Pig.*—This sample was first examined by treatment with *aqua regia* and evaporation to dryness, the residue being extracted with hydrochloric acid and water alternately until the washings were free from iron. Practically it was found almost impossible to obtain a white residue by such treatment, for although the substance was boiled by decantation four times with strong hydrochloric acid and four times with water, and then very carefully washed on the filter, still, after ignition, a very distinct colour was usually observed. It is necessary to treat the precipitate either with strong hydrochloric acid or to fuse with acid sulphate of potash, or with fusion mixture, in order to obtain a pure siliceous residue.

It should be mentioned that this sample contained 1·84 per cent of phosphorus, and my experience with such samples leads me to believe that the siliceous residue firs obtained on solution in an acid and subsequent evaporation is almost always contaminated with iron and a small quantity of phosphorus; on this account such residues should always be tested after ignition if accurate results are required. It appeared interesting to determine approximately the difference due to various amounts of impurity present in the residue after treatment with *aqua regia* and hydrochloric acid, as above described. The following table will illustrate this difference; in each case 2 grms. of the sample were taken for the experiment.

Method.	Weight of Precipitate.	Corresponding to Si per cent.	Colour of Precipitate.
Evaporation with HCl + HNO_3, imperfectly washed	0·139	3·24	Very brown.
Evaporation with HCl + HNO_3, washed better	0·131	3·05	Light brown.
Evaporation with HCl + HNO_3, well washed	0·1294	3·04	Red.
Evaporation with HCl + HNO_3, very carefully washed	0·1266	2·95	Light red.
Evaporation with HCl + HNO_3, treated with HCl after ignition	0·124	2·89	White.
Evaporation with HCl + HNO_3, after fusion and ignition	0·1204	2·81	Snow white.

From the above it will be seen that it is extremely difficult to thoroughly remove the last trace of iron from the residue after evaporation of phosphoric irons with *aqua regia*; the colour of the silica, however, serves as a

* Read before the Birmingham Philosophical Society, June 9, 1887.

very good index to its purity. In the case of other acids it is generally equally difficult to obtain a pure residue, but the colour is not so marked when an impurity is present. In the above sample on evaporation to dryness with sulphuric acid, a white residue was obtained which corresponded to 2·95 per cent of silicon. On fusion with acid potassium sulphate, both iron and phosphorus were extracted, and the snow-white silica left was equivalent to 2·73 per cent of silicon. It is evident, therefore, that with the sample in question, with careful working, the sulphuric acid method and the *aqua regia* process gave the same result; in each case this was too high, though with the sulphuric acid method there was little or nothing in the appearance of the precipitate to arouse suspicion.

In washing the residue students are more apt to make a mistake with the sulphuric acid method, as there is nothing in the colour of the solution or precipitate to indicate when the iron has been removed. It is therefore always necessary to test the washings until they are quite free from iron.

My attention was first strongly attracted to the sulphuric acid process by certain difficulties experienced in the analysis of a sample of very common Northamptonshire pig-iron. This had been analysed several times by the *aqua regia* method, and concordant results obtained, when I suggested to one of the students in the metallurgical department that its composition should be checked by dissolving in sulphuric acid. We were surprised to find that the check analyses gave very much higher results, although the residue was in all cases whiter by the sulphuric acid method than when *aqua regia* was used. In fact, the residue looked much better by the former method, though it was known to be less pure. By taking special care in washing the precipitate it gradually lost weight, until it was but little heavier than by the other process. But even when a constant weight was obtained, it was possible to extract nearly one-fifth of the substance by fusion with acid potassium sulphate and solution in cold water. The filtrate obtained after fusion contained titanium corresponding to 0·4 per cent of the original metal; it also contained a notable quantity of iron and a phosphate. It will be remembered that the iron in the residue did not turn red or brown on ignition, and from the conditions of its formation it is probable that this residue contained a basic compound, insoluble in acids, consisting of titanic oxide united with phosphoric acid and iron. There can be no doubt whatever as to the existence of these substances together in the white siliceous residue, but the exact form in which they occur is doubtful, as I have not succeeded in preparing a similar compound by evaporating titanium sulphate, sodium phosphate, and ferrous sulphate, with sulphuric acid.

I may mention that my friend Mr. Thomas Bayley was good enough to check some of my analyses of this sample, and substantially confirmed my conclusions; but we were sorry to find at the conclusion of our work that the drillings employed had been prepared by someone not familiar with such duties, and were contaminated with a little sand from the outside of the pig. Under these circumstances I have refrained from quoting the actual numbers obtained.

The conclusions arrived at from these experiments are as follows:—

1. That with cast-irons of specially good quality the silicon can be correctly estimated by evaporation with dilute sulphuric acid.

2. With phosphoric irons the residue obtained, though white, is often impure, and should be further treated in order to obtain accurate results.

3. With phosphoric irons containing titanium, the silica is contaminated not only with iron, but also with titanic oxide and phosphoric acid. The residue may be very nearly white and still contain 20 per cent of substances other than silica.

4. On treatment with *aqua regia* the colour of the residue is usually an indication of its purity.

RESEARCHES ON THE RELATIONS BETWEEN THE SPECTRA OF THE ELEMENTS OF INORGANIC SUBSTANCES AND THEIR PHYSIOLOGICAL ACTION.

By JAMES BLAKE.

In pursuing his researches always in the same direction the author has found that the action of a number of inorganic substances upon living matter depends on their isomorphic relations, and that all substances belonging to one and the same isomorphous group give rise approximately to the same physiological reactions. This fact was made known in a memoir read before the Royal Society of London in 1841, and it has been since confirmed by experiments made upon more than forty elements. Among all these elements there are only two whose physiological action does not agree with their isomorphic conditions,—nitrogen and potassium. When the same element forms two classes of salts belonging to distinct isomorphous groups, the physiological action of the salts of each class is quite different, but agrees with that of other substances of the group to which it belongs. Another fact observed by the author connects the physiological action of these substances to their molecular constitution,—*i. e.*, in one and the same isomorphous group the physiological action augments in intensity with the atomic weights of the elements present. The higher the atomic weight of an element the less of the substance is required to produce the same physiological reaction. This is a fact which demonstrates very distinctly the difference between these physiological reactions and ordinary chemical reactions. On considering the reactions of these substances from a physiological point of view, the author finds that it is by their action upon the nerve-centres of organic life, more or less specialised for each isomorphous group, that these reactions are explained. Thus the compounds of the alkaline metals act upon the internal ganglia of the heart; the compounds of phosphorus, arsenic, and antimony act upon the splanchnic ganglia; the substances of the magnesian group act upon the centre for vomiting; and in an analogous manner for other groups, it is by modifying the action of some nerve-centre that their physiological action is shown.

The spectroscope has opened out to us a path where physics and chemistry coalesce, where the molecular vibrations whose number we may count and whose length we may measure give rise to reactions of which we may grasp the results without having found the play of the forces by which they are determined.

Thanks to these discoveries which refer to the questions which engage us, the author considers that we are now in a position not merely to explain why chemistry could not render account of the results of his former experiments, but also find the direction in which must be sought the law which connects the physiological action of these inorganic substances with their physico-chemical properties.

In 1867 Mitscherlich discovered that the elements of one and the same isomorphous group have spectra which resemble each other, or are homologous. Still there are two elements, nitrogen and potassium, which form an exception to this rule, and these are the same two elements which form an exception to the rule, according to which the physiological action of the elements is connected with their isomorphous state. This fact has led the author to investigate if the action of these substances upon living matter is not connected to the molecular vibrations of which they are the seat, and which are revealed in their spectra. It is found that isomorphous substances give rise to the same physiological reactions when they have homologous spectra, but when in an isomorphous group there are found elements whose spectra do not resemble the spectra of other elements of the group, these elements with anomalous spectra give rise also to anomalous physiological reactions. When, as it has been said, an

element gives rise to two classes of salts the physiological action of these two substances is very different, and there is found a difference quite as strong between the spectra of the substances in the two classes. The physiological action of the elements in the various isomorphous groups shows that for two of these groups their action bears only upon the peripheric ganglionary centres: these are the group of the alkaline metals, and the group of phosphorus. As for the alkaline metals, the author has proved that after the injection of several grms. of sodium nitrate into its veins, an animal may live for a number of hours without any sign of a reaction given by a nerve-centre. The same fact reappears if we inject into the veins compounds of phosphorus, arsenic, and antimony. After the injection of 3 grms. arsenic acid into the veins we can observe no symptom which might indicate an action upon the cerebro-spinal nervous centres.

These two isomorphous groups have both very simple spectra. Of all the alkaline metals sodium and thallium have the simplest spectra. Their salts may be present in the blood in the greatest quantities in respect to their atomic weight, without reacting upon a central nerve-ganglion, whilst the salts of cæsium, with a more complicated spectrum, give rise to very slight symptoms when injected into the arteries. In the phosphorus group the same phenomenon is repeated. It is here again nitrogen with a very complex spectrum, which, of all the known elements reveals its presence by its action upon the nerve centres, and is distinguished in the sharpest manner from that of all the other elements of the same group. There are other facts which are better explained by referring them to the molecular vibrations of the reagents than by any other hypothesis. That the poisonous action increases with the atomic weight among substances having homologous spectra is a fact which is explained if we refer these physiological reactions to molecular vibrations. Further, the fact that these reactions rank among catalytic phenomena lends itself also to the same explanation better than to any other.

In the present state of our knowledge on the nerve vibrations, and also on the molecular vibrations, which hitherto lie hidden in the ultra-thermic region of the spectrum, the relation between molecular vibrations and physiological reactions remains, of necessity, a mere hypothesis; but the fine discoveries of M. Deslandres on the numerical relations subsisting among the molecular vibrations in spectra, promise to endow Science with a new means of approaching the problems of kinetic physiology. —*Comptes Rendus*, civ., p. 1544.

ON THE

INFLUENCE OF TEMPERATURE UPON SPECTRUM-ANALYTICAL OBSERVATIONS AND MEASUREMENTS.

By GERHARD KRÜSS.

Observations which the author has carried out for the purpose of determining the influence of temperature upon spectroscopic observations and measurements showed that this influence of temperature cannot be neglected and ignored, but must be considered by every chemist who wishes to make correct spectroscopic observations.

The more spectral analysis is applied as a sound method, the greater becomes the number of new observations and data added yearly to the facts already known.

In like proportion is increased the need for accurate localisation in the spectrum. Hence, for chemical researches in which we wish to depend upon the results of spectroscopic observations as *certainties*, the simple measurement by Bunsen's scale is no longer sufficient. It is now mostly supplemented by measuring arrangements like those mentioned by C. H. Wolff, the author, and others, which allow of the determination of localities in the spectrum being made with sufficient precision.

The accuracy which can apparently be reached by these methods has seldom been attained, as hitherto the temperature prevailing during spectroscopic measurements has seldom been taken into account.

The author was struck by this influence a considerable time back on determining the constants of his spectroscope on two days differing much in temperature.

Before entering upon the changes produced in the apparatus by differences of temperature it must be remembered that, according to the researches of Newton, Dale, Gladstone, Jamin, Schrauff, Landolt, and others, the refractive power increases in all liquids—excepting water between 0° and 4°—with the increase of density, *i.e.*, with the decrease of temperature. Rudberg showed that various solid bodies, such as quartz and arragonite, follow the same law, to which, however, there are exceptions. Among these is glass, in which, as proved by Arago and Neumann prior to Rudberg, the refractive power increases with the rise of temperature.

The following experiments were made to decide whether this decrease and increase of the refractive power of the prisms on changes of temperature, taken in conjunction with the changes of the other parts of a spectroscope due to the same cause have an appreciable influence upon spectroscopic measurements.

The universal spectroscope was fixed in a position convenient for the observer, and every agitation—indeed every superfluous contact—was carefully avoided. The room in which the apparatus was placed was heated to different degrees, and was each time kept for several hours as steady as possible at the same temperature. This was effected so completely that no variations occurred greater than 0·4°. The apparatus required from 1 to 1½ hours in order to completely adapt itself to a variation of 15° in temperature, wherefore the determinations were begun two hours after the apparatus was in air of a different temperature. In order to determine the influence of temperature upon these measurements it is sufficient to give the relative positions of four to five main lines of the solar spectrum in the numbers observed on the measuring drum.

From these numbers, which are given in a series of tables, it appears that the displacement of the spectral lines by temperature is considerable in comparison with the mean possible error of an observation. A difference of 25°, which is not impossible at different times of the year in work-rooms not constantly heated, may modify the position of the lines to the following extent:—With a glass prism of 60°, C may be displaced 7·5 towards the violet end of the spectrum, $\frac{D_1+D_2}{2}$ 7·67, E 9·83, *b* 7·50, and F 9·33 in the same direction. With a quartz prism having the same angle $\frac{D_1+D_2}{2}$ is displaced 4·10 towards the red extremity, E 2·27, *b* 6·36, and F 4·32. Therefore on a rise of temperature all phenomena of absorption and emission are displaced towards the violet with glass prisms, but towards the red with quartz prisms. These displacements are generally the greater the more refrangible the region of the spectrum in which they occur.

From 148 observations made by the author it appears that the mean error in localising a line is about 0·31 unit of the scale. As a difference of temperature of 1° effects a displacement of all lines by about 0·366 unit, a change of 1° in the temperature of a spectroscope can be observed with certainty.

In order to illustrate the errors which may be committed in spectroscopic determinations by neglect of the temperature the author gives in a table, under λ, the magnitude of the wave-lengths at 5°, and under λ_1 that which represents their position at 30°. From his table it may be seen that errors may spring from a neglect of the tem

perature in stating wave-lengths, since a rise of 5° is sufficient to transfer D_1 to the position of D_2. On a careful determination of the temperature many discrepancies in the statements of different authors may disappear.

Caution must especially be used in accepting the results of measurements which indicate displacements and distortions of lines in the spectra of the heavenly bodies.

The results, not merely of qualitative but of quantitative spectral analysis, will be rendered much more accurate by a due regard to temperature. This will especially occur when we are compelled to use parts of the spectrum whose neighbouring regions possess considerably larger or smaller absorptive powers than themselves.

The author points out the necessity of a general revision of the measurements of the spectra of the metals with regard to the temperature of the observation. Only an exact knowledge of the spark-spectra is of use to prevent such errors as the mistaken discovery of a supposed new metal.—*Liebig's Annalen*, Vol. ccxxxviii., p. 57.

TYROTOXICON: ITS PRESENCE IN POISONOUS CHEESE, ICE-CREAM, AND MILK.*

By VICTOR C. VAUGHAN.

(Concluded from p. 47).

Poisonous Ice-Cream.

June 13, 1886, I received from Dr. Henry Baker, Secretary of the Michigan State Board of Health, a pint bottle about two-thirds full of melted ice-cream, with the request that I would analyse it, as some eighteen persons had been seriously affected by eating of it. Dr. Baker also sent some of the vanilla which had been used as flavouring. It was thought that the poison would be found in the vanilla, because some lemon ice-cream furnished at the same gathering had not affected those who ate of it. As the readiest means of deciding this, my assistant Mr. Novie, and myself, took at first 30 drops each of the vanilla extract. No ill effects following this, Mr. Novie took two teaspoonfuls more, with no results. This settled the question of the poisonous nature of the vanilla more satisfactorily than could have been done by a chemical analysis.

We then added distilled water to the cream, and, after thorough agitation, filtered it. The filtrate was tested for tyrotoxicon by the method already given. The aqueous solution, after the spontaneous evaporation of the ether, was given to a cat. Within ten minutes the cat began to retch, and soon it vomited. This retching and vomiting continued for two hours, during which time the animal was under observation, and the next morning it was observed that it had passed several watery stools. After this, although the cat could walk about the room, it was unable to retain any food. Several times it was observed to lap a little milk, but on doing so it would immediately begin to retch and vomit. Even cold water produced this effect. This condition continuing, after three days the animal was placed under ether and its abdominal organs examined. We certainly expected to find marked inflammation of the stomach. But we really did find the stomach and small intestines filled with a frothy serous fluid, such as had formed the vomited matter, and the mucous membrane very white and soft. There was not the slightest redness anywhere. The liver and other abdominal organs seemed to be normal.

It should be remarked that this cat was about two months old. Attention is called to this, because young animals are affected by this poison much more readily than older ones. It requires a comparatively large amount of the poison to cause any marked symptoms in an old cat.

After having made these experiments I received from Dr. R. C. Moffitt, of Lawton, Mich., the following letter:—

"Lawton, Mich., June 21, 1886.

"Dear Doctor,—I understand from Prof. Charles Lawton, of this place, that the cream sent to Lansing, for examination, has been forwarded to you, so I write to give you the particulars. About two hours after eating the cream everyone was taken with severe vomiting, and after from one to six hours later with purging. The vomit was of a soapy character, and the stools watery and frothy. There was some griping of the stomach and abdomen, with severe occipital headache, excruciating backache and 'bone' pains all over, especially marked in the extremities. The vomiting lasted from two to three hours, then gradually subsided, and everybody felt stretchy, and yawned in spite of all resistance. The throats of all were œdematous. One or two were stupefied; others were cold and experienced some muscular spasms. A numb feeling, with dizziness and momentary loss of consciousness, was complained of by some. Temperature was normal, and pulse from 90 to 120. Tongue, dry and chapped. All were thirsty after the vomiting subsided, and called for cold water, which was allowed in small quantities, with no bad results. After getting out no one of the victims was able to be in the hot sun for several days, and even yet (about ten days after the poisoning) the heat affects myself. I attended twelve persons, besides being sick myself, and all were affected in pretty much the same way. Several complain yet of inability to retain food on the stomach without distressing them. The man who made the cream took a teaspoonful of it, and he vomited the same as those who ate a whole dish, but not so often nor for so long a time. All are affected with an irresistible desire to sleep, which can scarcely be overcome. Even yet some of us feel that drowsy condition, with occasional occipital headache.—Yours fraternally,

"R. C. Moffitt, M.D.

It will be seen from the above that the symptoms produced in the persons agree closely with those observed in the cat. Cases of poisoning from ice-cream are by no means rare, and I hope that those who have the opportunity will not fail to test for tyrotoxicon. In the Report of the Brooklyn Board of Health for 1885 an instance is given of the poisoning of more than 100 persons from ice-cream sent out from one restaurant. The chemist was unable to detect any mineral poison. The injurious results were attributed to the use of decomposed gelatin; but no gelatin of any kind was used in the Lawton cream. Other cases occurring in New York and Brooklyn have been attributed to the employment of artificially prepared vanillin for flavouring; but the vanilla extract used in the Lawton cream was not poisonous, as has been shown.

The circumstances under which tyrotoxicon develops require further study. As has been shown above it may develop in normal milk, kept in a clean bottle for three months; but it is evident that in some instances it appears much earlier. The production of the ptomaine is, in all probability, due, either directly or indirectly, to the growth of some micro-organism. In the cheese Dr. Sternberg found a new micrococcus; but whether or not there is any relation between this organism and the poison remains to be determined. In the cheese, milk, and cream, in all of which I have found the poison, there was present more or less butyric acid, and it may be that there is some intimate relation between butyric acid fermentation and the production of the poison. Some years ago Selmi obtained a ptomaine which resembles coniine, and pointed out that it might be formed by the action of butyric aldehyd on ammonia, thus:—

$$2C_4H_8O + NH_3 - 2H_2O = C_8H_{15}N.$$

* Read before the Chemical Section of the American Association for the Advancement of Science, August, 1886.

Or with butyric acid, thus:—

$$2C_4H_8O_2+NH_3+2H-4H_2O=C_8H_{15}N.$$

In like manner other fatty acids may react with the decomposing nitrogenous substances, forming alkaloidal bodies. Tyrotoxicon has no special resemblance, so far as is known, with coniine, but the possibility of these alkaloidal substances being formed in this way is worthy of mention. T. Lauder Brunton, in referring to the writer's discovery of tyrotoxicon, states that from the action of the substance he would infer the presence of two poisons. This is altogether possible. The writer has not been able to obtain the poison, as yet, in quantities sufficient to enable him to make an ultimate analysis of it. But that it is a chemical body produced by fermentation there can be no doubt.

If there be any doubt about the poison being produced by fermentation, the following experiment would seem to clear it up.

June 26th I took two samples, of one pint each, from a bottle of milk which had already undergone the lactic acid fermentation. These samples were placed in clean glass graduates. To one a piece of the solid portion of the poisonous custard, about the size of a filbert, and which had been washed with distilled water, was added. To the other no addition was made. These samples stood side by side for forty-eight hours. Both were then tested for tyrotoxicon. The one to which no addition was made gave no crystals, no odour, and when given to a cat produced no effect. The one to which the addition had been made yielded crystals which had the odour of tyrotoxicon, and which, when given to a very large old cat, produced frothing at the mouth and retching, but no vomiting or diarrhœa, and the next day the animal was able to eat food and seemed to have recovered. I am quite certain that had this been administered to a young animal the result would have been more marked.

It is well known that milk, while undergoing the lactic acid fermentation, does not possess any such poisonous properties as those belonging to tyrotoxicon. There is no evidence, then, that the poison is connected in any way with the ordinary decomposition of milk. The following extracts from a letter just received from the maker of the Lawton cream shows that the attention given to the milk and vessels was all that could be desired:—

"The milk of which the cream was made was fresh and sweet morning's milk, only reserving with it the cream of the milk of the night before from the same cows. The milk is kept in a cool, clean milk cellar. The custard was made about noon that day, and immediately afterwards the process of freezing was begun. The vessels were all thoroughly cleaned. There was no possibility of any impurities adhering to them, for they were scalded, wiped, and dried before being used. The only ingredients used were the milk, cream, eggs, sugar (best granulated), and the flavouring.

"The lemon cream was frozen first, then taken out, put into the packers, and packed solid with ice and salt. Then the vanilla cream was frozen in the same manner. I used the best Jennings's extract, about the usual quantity, not in excess. The cream was eaten in the evening by many people of the village. All of those who ate of the vanilla cream were made sick, and none of those who ate of the lemon cream suffered any inconvenience.

"Now the milk was the same in both, milked from the same cows the same morning that the cream was made, so that there was no difference in the custard used in making the vanilla cream and the lemon cream, but it turned out that the one made people sick and the other did not."

"We have continued making cream since in the same manner, without the least change of the ingredients or the apparatus, except we have not used vanilla extract, but lemon and pine-apple, and it has been freely eaten and no one has been made sick by it.

"Clearly in my mind the milk does not account for the trouble. One thing further: of course the cream which you examined has been made since the 9th day of June, and may have undergone changes which would result in generating the poison referred to in the papers [certain newspaper accounts of the finding of the poison], and which would not have been found in the cream had it been examined when fresh.

"If there is anything farther that I can furnish you in regard to facts or circumstances in connection with the ice-cream, I will be willing at any and all times to give the fullest information possible. Hoping to receive the correct analysis soon, I remain yours respectfully,

"J. W. Johnson."

That the poison which I found in the cream was the same as that which affected the people cannot be doubted after comparing the symptoms produced in the cat with those observed by Dr. Moffitt; and, as has been stated. the experiment on the cat was made before I received the letter from Dr. Moffitt. The cream was made on the 9th of June, and the poison separated on the 14th.

I wrote to Mr. Johnson asking several questions, which he has kindly and fully answered. As the nature of the questions is shown in the answers, I will simply give the answers:—

"(1.) The milk from all the cows was mixed together in the making of the custard."

"(2.) The custard for the lemon and vanilla was all one custard; made and mixed before the extracts were put in."

"(3.) We had previously used the same brands of extracts (Jennings's best), both lemon and vanilla, with no bad results."

"(4.) The food of the cows in the morning and evening consists of oats and corn, ground together and fed dry, with clover hay. I have never seen anything suspicious in the pasture or food. There is a running stream of water, coming from a spring in the pasture. There is plenty of shade. At evening the cows are driven from the pasture and placed in the stable or yard, according to the season. The stable and yard are open for inspection at any time. My residence is in the centre of the village, and the Board of Health would not allow me to stable and yard my cows there if there were any bad odours during the summer."

"(5.) The teats are thoroughly washed before each milking."

After receiving the above details concerning the making of the cream, the following experiment was made:—

July 8th.—To 1 quart of night's milk a piece of the solid portion of the Lawton cream, about the size of a filbert, was added. This residue had been left on the filter-paper ever since the analysis of the poisonous cream, June 14th, and it was on June 8th when the first milk for the preparation of the Lawson cream was collected. This dried and hardened lump was crumbled into the milk, which was placed in a clean tin pan and set in a cool cellar. July 9th.—To a quart of morning's milk, another small bit of the infected material was added, and this milk was also placed in the cellar. At 1 p.m. both portions of milk were poured into a clean earthenware jar, and four fresh eggs beaten, and 1 pint of granulated sugar were added. The whole was thoroughly agitated, then allowed to stand at the temperature of the room until 4 p.m., when it was placed in the ice-box of a refrigerator, surrounded by ice, and here kept until 7 a.m. the next morning, July 10th. Then 3 ounces of the custard were stirred up with distilled water, filtered, the filtrate rendered alkaline and agitated with ether. The residue, on the evaporation of the ether, was dissolved in a little water and given to a kitten about two months old. Immediately the kitten manifested the symptoms of poisoning by tyrotoxicon, which have already been described. I began the analysis of this custard in the morning before having my breakfast, and getting a little on my finger, in carrying the jar, I tasted of it. Within

a very few minutes I was nauseated, and ten minutes after taking it I vomited. The prompt action of so small a quantity was probably due to the condition of my stomach. At 2 p.m. of the same day I took one teaspoonful of the custard. Within thirty minutes there was marked nausea and some violent retching, but no vomiting. At 3 p.m. the symptoms having abated, I took a tablespoonful more of the custard. At about 3.30 I began to vomit freely. The nausea continued for about an hour. After this there would be passing sensations of sickness. At 8 p.m., while visiting a patient, I was taken very suddenly and sharply with nausea and griping pains in the abdomen. I again vomited, and had one watery stool. After this there was no further trouble. The occipital headache, mentioned by Dr. Moffitt in his letter, was very marked for some hours after taking the custard. It consisted of sharp lancinating pains, which were confined wholly to the occiput. The nausea was peculiar. I cannot say that there was pain in the stomach. A sickening taste would be felt in the mouth, and a peculiar very sickening odour—which I recognised as that of the isolated poison—would intensify the nausea. The throat and mouth seemed filled with a sticky tenacious mucus. In short, the effects on these parts resembled those which I have experienced from an over-dose of atropia.

I think that this experiment explains the poisonous nature of the vanilla cream. The fermentation going on in the custard, and probably begun in the milk, was arrested in that part flavoured with lemon by the freezing which began immediately, But while the lemon cream was being frozen, that part of the custard which was to be made into vanilla cream continued to ferment, and before the freezing process was begun enough of the poison was generated to seriously affect those eating of it.

The maker of the cream does not give us any exact information concerning the length of time which elapsed between the making of the custard and the freezing of that portion of it flavoured with vanilla. He only states that the lemon cream was frozen first. Recently I have received from Lawton a letter giving me more exact information on this point, also some valuable knowledge concerning the conditions under which the cream stood. I take from this letter the following extract:—"The cream was frozen in the back end of an old wooden building on Main Street. It is surrounded by shade, has no underpinning, and the sills have settled into the ground. There are no eave-troughs, and all the water falling from the roof runs under the building, the streets on two sides having been raised since the building of the house. The building had been unoccupied for a number of months, consequently has had no ventilation, and, what is worse, the back end (where the cream was frozen) was last used as a meat market. The cream which was affected was that portion last frozen; consequently it stood in an atmosphere more like that of a privy vault for upwards of an hour and a half or two hours before being frozen. It seems to me that anything so sensitive to surroundings as milk could not escape being affected by such an atmosphere."

The above, from a non-professional but evidently a very sensible observer, furnishes information of great value.

It should be remarked that in the custard which I made there was nothing peculiar in the taste. It was sweet and pleasant. But while it was not at all acid to the taste, it gave a decidedly acid reaction as tested by litmus, and was not amphoteric in reaction, as cow's milk frequently is.

It is possible that the presence of the large amount of albumen in the custard, from the eggs, hastened the fermentation. I believe that makers of cheese have found by experience that a large amount of albumen in cheese renders decomposition more easy.

How the special germ which produces the poison found its way into the Lawton cream I cannot say, but that it was either present in the milk or was contained in the eggs used I think cannot now be doubted.

The discussion of the possible relation between tyrotoxicon and cholera infantum will be omitted here, as it would not be suited to a chemical journal.

NOTE.—Since the above article was read at Buffalo tyrotoxicon has been found in milk by Drs. W. K. Newton and Shippen Wallace of New Jersey (see *Philadelphia Medical News*, Sept. 25, 1886), and by Prof. Sherver, chemist to the Iowa State Board of Health.—*Journal of Analytical Chemistry*, Vol. i., p. 24.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

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(Continued from p. 42).

THE solids extracted by petroleum spitit from the four parts of the plant are identified as fixed oils;* associated with a volatile principle (0·2 per cent) in *extract* (2), and with traces of chlorophyll in *extract* (3).

Fixed oil (1) was crystalline in structure. It was soluble in ether, chloroform, benzol, carbon disulphide, and amyl alcohol; incompletely soluble in cold or boiling alcohol, acetic ether, and ammonium hydrate. It was coloured pale green by sulphuric acid of 1·634 specific gravity, and changed to a bright-green colour by calcium disulphide, but formed no emulsion with it. Phosphoric acid coloured it yellow. The fixed oil was saponified, and a white soap separated. This was decomposed, and the fatty acids recovered. Glycerin was separated from the soap filtrate.

Fixed oil (2) was dissolved with difficulty in boiling 95 per cent alcohol, and hardened and discoloured by absolute alcohol. It was not saponified. Crystalline solids were separated by precipitating the alcoholic solution with magnesium acetate. They melted at 85° C., and at 60° C., respectively.

Fixed oil (3) was soluble in alcohol, ether, chloroform, benzol, carbon disulphide, oil of turpentine, almond oil, glycerin, and slowly soluble in acetic ether. The presence of free fatty acids was demonstrated. The fixed oil was coloured dark green by syrupy antimony chloride; on adding to it sulphuric acid of 1·475 specific gravity, and a small quantity of zinc, hydrogen was generated, and the solubility of the oil in the acid liquid was accompanied by a rosy tint given to the solution.

Fixed oil (4) was crystalline in structure. It was soluble in warm absolute alcohol, in cold acetic ether, chloroform, benzol, amyl alcohol, ether, carbon disulphide, and glycerin. It was saponified, and a white soap separated. The fixed oil was coloured dark brown by alcoholic ammonia, and a mixture of ferric chloride solution and powdered rosaniline gave a violet-coloured reaction with it.

These fixed oils differed in their physical characters and chemical reactions. This difference may be due to the presence of free fatty acids and glycerides in varying proportions in the four parts of the plant. It is of interest to note that in the subterranean part of the *Yucca*, the oil extracted from the bark was solid at the ordinary temperature; from the wood it was of a less solid consistency while the yellow base of the leaf contained an oil quite soft, and in the green leaf the oil was almost fluid.

Extract (2) contained an oil of low melting point. It melted at 36° C. An alcoholic solution was fractionally precipitated with magnesium acetate, and three members of the fatty acid series were isolated. The quantities obtained were small, and it was impossible to do more than to take the melting point of two of the purified

* Fixed Oils. *Science*, Sept. 11, 1885.

Summary I.—*Petroleum Spirit Extracts.*

	Solids extracted.	Character of residue.	Reaction with litmus.	Melting point.	Solidifying point.
1. The bark of the root ..	1·24 per cent.	Fixed oil.	Slightly acid.	60° C.	Solid at ordinary temperature.
2. ,, wood ,, ..	0·55 ,,	,, ,,	Neutral.	36° C.	
3. ,, green leaf	2·20 ,,	,, ,, Chlorophyll.	Acid.	Semi-fluid at ordinary temperature.	15° C.
4. ,, yellow base of leaf.	1·10 ,,	Fixed oil.	Faintly acid.		12° C.

crystalline residues. They melted at 85° C. and at 60° C. respectively. It is a well-known fact that a mixture of fat acids in certain proportions has a lower melting point than those of its constituents.

Alkaloids and volatile-alkaloids were not detected in the *petroleum spirit extracts.*

Ether Extracts.

Extract (1), *Bark of the Root.*

The residual powder from the petroleum spirit extraction was dried until thoroughly freed from petroleum spirit. It was then macerated with Squibbs's stronger ether in the apparatus already described. The *ethereal extract* was filtered from the powder. It was a clear crimson-coloured liquid, tinted by some red colouring matter dissolved, and acid in reaction. The *extract* was slowly evaporated at the ordinary temperature; white needle-shaped crystals were seen as the liquid concentrated. The *ethereal residue* was of a resinous character. It was ruby-coloured, transparent, and of a softer consistency than ordinary resin. Microscopically, the *residue* was identified as a resin by its colour reaction with Hanstein's aniline violet solution.* The *ethereal residue* was treated with petroleum spirit to remove any traces of fat that may have been extracted with it. It was heated in a small tube, at 50° C. it experienced a slight change, and melted at 70° C. For a determination of the total solids, a definite volume of the *ethereal extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C...	3·16 of solids.
,, ,, ,, 110° C...	3·16 ,,
	0·00 of loss.

The resin was incompletely soluble in 95 per cent alcohol, absolute alcohol, and amyl alcohol; readily soluble in ether; not appreciably soluble in chloroform, benzol, and carbon disulphide. It was dissolved by sulphuric acid to a colourless solution, which, on warming, turned to a yellow colour, and gradually darkened to a dull brown colour, fading to a pale yellow.

An attempt was made to separate the white needle-shaped crystals mentioned above. The *ethereal residue* was agitated with acetic ether. The liquid was filtered from the insoluble matter and evaporated. Traces of a resinous substance were separated. The insoluble matter was treated with boiling ether, filtered hot, and the filtrate concentrated. On cooling, the white needle-shaped crystals reappeared. They were insoluble in water and in acetic ether.

A separate portion of the *ethereal extract* was evaporated, and treated with warm distilled water. The aqueous extract was made up to a definite volume, and a known quantity evaporated, dried, and weighed. The amount of total solids was almost inappreciable by weight. The aqueous extract was not coloured by iron salts, and it did not form a precipitate with alum and gelatin solution, lead acetate, potassio-mercuric iodide, nor gold chloride solutions; showing absence of tannin, gallic acid, and alkaloids. The *ethereal* extract was directly tested for these compounds, and with negative results. A portion of the aqueous extract was evaporated to dryness, and treated with potassa solution, and the residue dissolved with no colouration. Another portion of the aqueous extract was agitated with acetic-ether, and the liquids were separated; on evaporating the acetic ether solution, traces of a residue were obtained which sulphuric acid acted upon. A resinous substance separated from the greenish-coloured acid liquid; the former was partially disintegrated by cold water.

The specific gravity of the resin was 1·091.

Extract (2), *the Wood of the Root.*

The residual powder from the petroleum spirit extraction was macerated in stronger ether. The *ethereal extract* was of a reddish-yellow colour, slightly acid in reaction. It was slowly evaporated at the ordinary temperature, and as the liquid concentrated, white needle-shaped crystals appeared, and presented the same physical structure as the crystals found in the *ether extract* (1).

The *ethereal residue* was identified as a resin. It was a transparent, ruby-coloured substance, and acid in reaction. It was heated to 50° C., at that temperature its colour deepened, and at 70° C. it melted. The specific gravity of the resin was 1·091. A definite volume of the *ether extract* was evaporated, dried, and weighed to determine the amount of total solids.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C.	1·70 of solids
,, ,, ,, 110° C.	1·45 ,,
	0·25 of loss.

The resin was examined by Hirschsohn's scheme* with a view to classify it with known resins. It was imperfectly soluble in 95 per cent alcohol and chloroform; soluble in ether. The alcoholic solution gave a turbidity with lead acetate, not cleared upon boiling, and with ferric chloride formed a clear mixture. Concentrated sulphuric acid dissolved the resin, leaving a dark yellow-brown liquid which faded to a dull yellow colour. The sulphuric acid solution, when mixed with alcohol, changed to a pale grey colour. On addition of water to the acid solution, there was no colouration nor separation of the resin. Alcohol containing hydrochloric acid gave no colour reaction with the resin. Bromine solution added to the chloroform-resin extract, and iodine solution to the ether-petroleum-resin extract, gave no reactions. Sodium carbonate at the ordinary temperature had no effect on the resin, but on boiling the liquid was coloured yellow.

By the above examination, this resin was thown out of the numerous classes of described resins. It is proposed to name it yuccal.†

Yuccal was soluble in boiling absolute alcohol and acetic ether; incompletely soluble in benzol, carbon disulphide, alcoholic ammonia, and cold acetic ether. The red colour of the resin was removed by cold acetic ether, a transparent substance remaining, soluble in hot acetic ether.‡ Yuccal was dissolved by potassio-mercuric iodide.

* "Botanical Micro-Chemistry." Poulsen-Trelease. Boston, 1884 p. 59.

* E. Hirschsohn, "Watts's Chem. Dic.," vol. viii., Pt. ii., p. 1743.

† I suggest that in future all resins be distinguished by the terminal syllable *al*, for uniformity of resin nomenclature. Yuccal; *Science*, September 11, 1885, p. 210.

‡ I have examined the action of acetic ether as a solvent for resins. Cold acetic ether dissolved ordinary resin, turpentine, styrax, tolu-balsam, mastic, elemi, Canada-balsam, Peru-balsam, copaiba-balsam, Venice-turpentine, and incompletely spruce-gum, and yuccal. In hot

It reduced aqueous solutions of gold and platinum chlorides. A blood-red colour reaction was obtained by warming a small quantity of the resin on a crucible lid with a crystal of ammonium molybdate and a few drops of nitric acid. On adding to the resin mixture a few drops of strong sulphuric acid, and again warming, it was dissolved. Warm dilute nitric acid dissolved the resin, colourless; cold nitric acid gave a brownish-green colour reaction.* Yuccal was heated on platinum foil, and as it decomposed the fumes that were given off were pleasant and aromatic. Tests failed to show the presence of benzoic or cinnamic acids.

The *ethereal residue* was treated with warm water, and on cooling, the liquid was agitated with acetic ether, which was separated, and when evaporated yielded a small quantity of resinous substance. The *ethereal residue* insoluble in water was treated with boiling ether, and as the liquid concentrated, the white needle-shaped crystals were seen floating in it, but on further concentration they could not be seen, and a yellow greasy-looking mass settled in the bottom of the beaker. On driving off the ether, a transparent and ruby-coloured resinous substance remained. The aqueous extract obtained in the way described above gave no colouration with iron salts, and no precipitate with gelatin and alum solution, potassio-mercuric iodide, or gold chloride solutions. Fehling's solution was not reduced by boiling, though the aqueous extract was boiled with acid, then rendered alkaline before adding the copper test. The preceding tests gave negative results for gallic acid, tannin, alkaloids, and glucosides. A portion of the aqueous extract was acidified and agitated successively with different solvents, for glucosides, bitter principles, and alkaloids which may be removed from solution by this means. The acid liquid was then rendered alkaline with ammonia, and agitated successively with the same order of solvents that were used with the acidified liquid. No solids were separated by these methods. The *ethereal residue* insoluble in water was treated with alcohol; and yielded traces of a resinous substance. The residue insoluble in water and alcohol was not dissolved by ether, acids, or alkalies.

Yuccal, or the *ethereal residue* soluble in ether and alcohol, was saponified, and the soap boiled with lead acetate. The yellow masses were collected on a filter and treated with boiling ether, and the filtrate was slowly evaporated. The residue was a granular solid. This substance was imperfectly purified by repeated boiling with ether, and a solid of crystalline structure obtained. It gave an acid reaction with litmus, and a red colour with concentrated sulphuric acid. The acid dissolved a substance enclosing the crystals, leaving the structure of the latter uninjured and coloured. Strong nitric acid dissolved the crystals with no colouration. They were soluble in absolute alcohol, amyl alcohol, benzol, chloroform, glycerin, and a solution of alcoholic soda; soluble in potassium iodide, potassium chromate, mercurous nitrate, cobalt nitrate, potassium ferro- and ferri-cyanide solutions; insoluble in ammonia and aqueous alkalies.

Yuccal was treated with spirit of different strengths, as a means of separating resin acids if any were present. It was treated with 85 per cent spirit; an opaque brown substance was left undissolved, which was soluble in absolute alcohol, insoluble in ether, and coloured brown by concentrated sulphuric acid. The colour was not discharged by alcohol or ether. The 85 per cent spirit solution was evaporated, and the residue treated with 50 per cent spirit and a small quantity of a brown residue was insoluble. The 50 per cent spirit solution on evaporating left a non-crystalline, transparent, reddish-coloured solid, acid to litmus. It was coloured cherry-red by concentrated sulphuric acid, and slowly dissolved to a yellowish-red liquid.

(To be continued).

acetic ether spruce-gum and yuccal were soluble. The following resins were insoluble in hot or cold acetic ether, guiacum, sandarac, shellac, benzoin, olibanum, ammoniac, myrrh, galbanum, and asafœtida.

* A reddish-yellow decomposition product resulted from the action of nitric acid on many resins which followed generally quite soon after adding the acid to a small quantity of the resin (0·1 grm. of the resin and 5 c.c. of nitric acid 1·4 sp. gr.). But the reaction which took place varied according to the conditions, *i.e.*, strength of acid used, the application of heat to the resin acid mixture, or the addition of solvents to the mixture. The more concentrated the acid the more rapid was the reaction. The application of heat also hastened the change, especially if a more dilute acid was used in the mixture. Some solvents acted like heat by increasing the energy of the reactions. Alcohol and ether were active solvents, and the reaction was attended by the escape of nitrous fumes from the combination of alcohol or ether and nitric acid. Chloroform and benzol were indifferent. Amyl alcohol acted feebly.

NOTICES OF BOOKS.

"*Creation*," "*Supplement to Creation*," and "*Constitution of Matter*." By William Andrew. Providence, U.S.A.: Angell and Co., J. A., and R. A. Reid. 1886.

The theory of the creation, constitution, and attributes of matter and force, as set forth in these three pamphlets, is in many respects a most remarkable one. There is a good deal in it which invites serious consideration, but at the same time there are some points to which we must take exception as being opposed not only to generally accepted hypotheses, but also to observed facts.

At the commencement we read, "Space, matter, motion, and may be others, are Nature, or the elements that compose all Nature. . . . An element of Nature is infinite in time and space, and it can neither be created or uncreated; and it has always been what it is now, and must always be what it is. . . . Matter has always been matter; it cannot be made from anything else, and matter is wherever space is; it has always had the same nature as it has now." These are curious statements. Matter, as we now know it, has very probably changed its nature in every respect. If the modern theory of the Genesis of Elements be a true one,—and it is based on very firm grounds,—the nature of all matter has changed from its original unatomic, unchemical, and unelectrical condition to that in which it now exists. If ether exists and is matter, it is certainly of a different nature to any matter we know.

Mr. Andrew then goes on to explain his theory of the universe, and he gives very great prominence to elementary motion, which is the motion an atom possesses to carry it through space irrespective of neighbouring and surrounding objects. This motion is very different from the popular conception of motion: we say a body is at rest if it is not moving in relation to the earth, while at the same time it may be moving through ether with enormous velocity. With respect to ether, atoms on the earth do not vibrate equally. Thus an atom is vibrating in itself in every direction, but the earth is rushing through space (or ether) at over 1000 miles per minute; therefore the vibrations of all atoms in ether are shorter in one direction than in any other. If the earth were really to come to rest the character of these vibrations would necessarily change, but with what effect it is not worth while considering.

A point worthy of attention is this: some people think, as Mr. Andrew tells us, that as time goes on the motion of the heavenly bodies will decrease, and their temperature will diminish, until nothing remains but a dead frozen mass in the centre of space; but he asks, how can infinite space have a centre? one point is as much a centre as any other.

From this we might argue back that as the necessary conclusion to the universe cannot exist, may not the other points in the argument be erroneous? No energy can be wasted, so, although we are continually losing heat by radiation into space, it will one day be reflected back again to us from those bodies which are now receiving it.

"There is a principle in Nature which I call certainty." This statement is explained as follows:—If we plant an acorn we are certain that, if anything grows from it, it will be an oak, not a pine, or a geranium, or a horse: there are, however, with us many things which we consider as uncertain,—for example, the weather,—but on reflection we can only admit that the apparent uncertainty is due to our want of knowledge. If our minds were infinite there would be no such thing as chance or mystery, but we should be able, by knowing all the causes, to predict all the effects in Nature.

The New Religio-Medici. Chapters on Every-day Subjects. By FREDERICK ROBINSON, M.D. London: Elliot Stock. 1887.

THE chapters in this book may be considered more as Essays on somewhat kindred subjects than as the gradual exposition of any particular views on any one subject as a whole. Some of them are in part reprinted, with alterations and additions, from the *Churchman* magazine, where they originally appeared.

Despite the semi-medical title of the work, there is really little which can be legitimately considered as requiring notice in a journal such as the CHEMICAL NEWS, but at the same time there are some portions which attract our attention—notably the chapter on "Faith Healing."

We must confess to some surprise when we read that "The supporters of this doctrine, there is reason to believe, are increasing in numbers." Such a doctrine, founded on a "single isolated apostolic utterance" and resting almost entirely on superstition and coincidence, would be more likely, we think, to be dying out in these days than to making material headway.

We acknowledge unhesitatingly that the condition of the mind of a patient must have very great influence on the success or non-success of any particular medical treatment. People may often worry themselves into illness, and, on the other hand, some can throw off an apparently severe indisposition with very little difficulty; but at the same time, when a definite disease exists, Nature requires more than "faith" to keep up the strength of the body while *she* effects the cure.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 1, July 4, 1887.

Alteration experienced by Retort-carbon when it Serves as a Positive Electrode in the Decomposition of Acids.—MM. H. Debray and Pechard.—If we employ electrodes of retort-carbon in order to decompose acid solutions by means of a current, we remark that the positive electrode is disaggregated more or less rapidly, forming a very finely-divided powder. The authors think that this disaggregation is not a mechanical phenomenon, but results from a more or less profound alteration of the substance, and that the pulverulent product yielded by the carbon must approximate in composition to the residues of alloys which M. Debray has described in Nos. 23 and 24 of vol. civ. of the *Comptes Rendus*. This powder contains, in fact, oxygen, water, and even nitrogen if nitric acid has been submitted to electrolysis. These various substances combine with the carbon under the influence of the current, which confirms the part played by electricity in the formation of metallic residues. The total quantity of oxygen fixed by the carbon, which serves as an electrode in the decomposition of acids, may reach 9 or 10 per cent, whilst the quantity of water may reach 8 per cent.

Certain Double Phosphates of Thorium and Sodium or of Zirconium and Sodium.—L. Troost and L. Ouvrard.—Sodium metaphosphate yields with thoria and zirconia double phosphates, which have analogous compositions, recalling those given by the action of potassium metaphosphate under similar conditions. The double metaphosphates of thorium and sodium thus obtained are not isomorphs of the double phosphates of zirconium and sodium. Sodium pyrophosphate gives, with thoria, double phosphates which have neither the same crystalline form nor the same composition as those obtained with zirconia.

Fluorescences of Manganese and of Bismuth.—Lecoq de Boisbaudran.—This paper does not admit of useful abstraction.

Report on M. de Mondésir's Memoir on the Rapid Determination of Active Calcium Carbonate in Soils.—MM. Debray, Reiset, and Schlœsing.—The authors consider that the instrument and the method devised by M. de Mondésir will be of great value for practical purposes.

Racemic Camphol and its Derivatives.—Alb. Haller.—The facts which the author has observed lead him to consider the camphol of amber as a mixture of dextro- and lævo-camphols in which the former predominates.

Synthesis of Pilocarpine.—MM. Hardy and Calmels.—The synthesis of pilocarpine is obtained by setting out from β-pyridino-α-lactic acid. It consists of two stages: transformation of β-pyridino-α-lactic acid into pilocarpidine and conversion of the latter into pilocarpine. The authors have found experimentally that synthetic pilocarpine produces the same symptoms in animals as does the natural product.

Zeitschrift für Analytische Chemie. Vol. xxvi., Part 1.

Determination of Ammonia in Arable Soils.—W. Knop.—The author first stirred up the soil in question with a saturated solution of borax, and then added chloride of soda mixed with bromine (3 to 4 grms. per litre) previously dissolved in a minimum of soda-lye. Soils, on agitation with an alkaline liquid, undergo a contraction in consequence of which too little nitrogen gas is obtained in the subsequent volumetric determination. Afterwards he employed a solution of sodium hypobromite poured into a solution of borax mixed with small quantities of ammonium chloride. This liquid, without any especial addition of caustic soda, decomposes the ammonia completely and does away with the errors arising from the contraction of the soil. The quantities of soil taken for analysis should not be too large, 100 grms. being the preferable amount. The agitation of the sample with the decomposing liquid should not be prolonged.

Application of Oxalic Acid for the Separation of different Metals from others in Qualitative and Quantitative Analysis.—C. Luckow.—Already inserted.

Separation of Mercury and Palladium from each other and from Lead, Copper, and Bismuth.—Th. Rosenbladt.—Already inserted.

Quantitative Determination of Boric Acid.—Th. Rosenbladt.—Already inserted.

Iodometric Determination of Zinc and Cadmium Sulphides.—P. von Berg.—The author proceeds as follows:—The zinc sulphide, washed with water containing sulphuretted hydrogen, is drained and rinsed into a stoppered bottle from which the air has been expelled by a current of carbonic acid, and which has been charged with about 800 c.c. of recently boiled water (allowed first to cool in a stoppered vessel). The filter is also introduced, and the whole well and repeatedly shaken. Thus, the precipitate became suspended in the water in a state of minute and uniform division. Hydrochloric acid of moderate strength is next added, the liquids are mixed

by shaking, and a standard solution of iodine is added with a pipette. The completion of the reaction can be recognised by the permanent colouration of the liquid. The free iodine is then immediately determined with sodium thiosulphate. The solutions of iodine and of thiosulphate are standardised by means of potassium dichromate. This method is applicable also to cadmium, but not to cobalt, nickel, and manganese.

New Reaction of the Hyposulphites.—Prof. L. L. de Koninck.—If the alkaline hyposulphites are treated with aluminium in presence of potassium or sodium hydroxide they yield alkaline sulphites, which may be detected in the solution by means, *e.g.*, of sodium nitroprusside.

Detection of Ammonia, Nitrous or Nitric Acid, and Hyposulphurous Acid in a Mixture of Alkaline Salts.—Prof. L. L. de Koninck.—The aqueous solution of the saline mixture is introduced into a small fractionation flask, the steam delivery tube of which is bent vertically downwards, and opens into a U-tube containing a few drops of Nessler reagent. Some soda lye is then introduced into the flask, the neck is stoppered, and the contents are heated to a boil. As soon as the first drops have passed over it may be seen by the behaviour of the Nessler reagent whether ammonia was present in the solution. The distillation is continued until all the ammonia has passed over, the liquid is let cool, a few clippings of aluminium foil are introduced, and after a short time the liquid is again heated to a boil. If nitrous or nitric acid has been present it is reduced to ammonia, which can again be detected by means of a fresh portion of Nessler reagent. In the residue sodium sulphite is sought for; its presence proves that a hyposulphite was originally present.

Determination of Fatty Acids in Soaps.—Dr. B. Schulze.—The weighed samples of soaps are placed in small Erlenmeyer flasks, decomposed by dilute sulphuric acid, and the liberated fatty acids are dissolved by ether poured in so as to form a stratum above the acid. When the soap is completely decomposed the lower aqueous acid liquid is drawn off as completely as possible by means of a pipette, cautiously introduced; distilled water is added, shaken a little, and again drawn off, repeating this operation twice more. If, in this process, a little of the ethereal solution enters the pipette (which will not occur if sufficient care is taken) the complete withdrawal is rendered rather more difficult, since the vapours of the ether tend to force back the liquid out of the pipette, but it may be effected in the end, and losses of fatty acids need not be feared. When the aqueous solution has been for the fourth time removed down to a few drops the pipette is washed within and without with ether and one or two drops of barium chloride are let fall into the flask. By a little shaking all the sulphuric acid still present is precipitated, and with care little water is left below the ethereal solution, so that the latter may be at once poured upon the filter and treated as usual in determinations of fatty matters.

Contributions to the Analysis of Butters.—F. W. A. Woll.—A comparison of the results obtained by different analytical methods.

Detection and Determination of Lactic Acid in Physiological and Pathological Cases.—R. Palm.—The comminuted substance is exhausted with ether, which dissolves only lactic acid, fats, and possibly colouring-matters. The ethereal extract is evaporated on the water-bath to the consistence of oil, the residue is dissolved in water, leaving behind the fat, and the filtered aqueous solution is mixed with basic lead acetate. If a precipitate is formed it is filtered off. The filtrate, if it does not already contain an excess of basic lead acetate, is mixed first with this reagent and then with alcoholic ammonia as long as a precipitate is perceptible, when, if lactic acid is present, lead lactate falls of the constant composition $3PbO,2(C_3H_6O_3)$.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or auch trade notices aa should legitimately come in the advertising columns.

Tobacco Analysis.—Will any of your correspondents state their experience of (1) Estimation of nicotine in tobacco; (2) Detection of glycerin in tobacco?—W. S.

The London Hospital and Medical College,
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The SESSION 1887-88 will commence on Saturday, October 1st, 1887. The New Buildings which were opened by T.R.H. The Prince and Princess of Wales, on May 21st, afford more than double the accommodation which was provided formerly.

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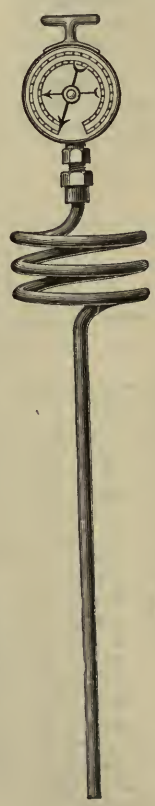

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THE CHEMICAL NEWS.

Vol. LVI. No. 1446.

ON A SHARP LINE SPECTRUM OF PHOSPHORESCENT ALUMINA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

Since the publication of my paper "On the Crimson Line of Phosphorescent Alumina,"* I have been working unremittingly on the subject, with the view of clearing up the differences existing between M. Lecoq de Boisbaudran and myself in respect to the cause of the red phosphorescence of this earth.

It will be remembered that M. de Boisbaudran stated at the Académie des Sciences, in December last, that the presence of chromium was indispensable to the production of the red fluorescence of alumina; the $\frac{1}{100}$th and even the $\frac{1}{1000}$th part of chromic oxide being sufficient to give a brilliant red fluorescence as well as its special spectrum to alumina, whilst with the $\frac{1}{10000}$th part of chromic oxide a very visible rose-colour was still obtained.

In my paper above referred to I gave reasons for differing from the conclusions of the eminent French chemist. I explained how I purified alumina so as to secure its freedom from chromium; how I then tested this alumina and obtained its characteristic phosphorescence and spectrum; how I next mixed chromium with it in varying proportions without conferring on the alumina phosphorescence to any marked extent over what it had before the addition of chromium; and how then I fractionated my purified alumina by different methods, and found that the crimson-line-forming body concentrated towards one end of the fractionations. Finally I suggested the following four possible explanations of the phenomena observed:—

"1. The crimson line is due to alumina, but it is capable of being suppressed by an accompanying earth which concentrates towards one end of the fractionations.

"2. The crimson line is not due to alumina, but is due to the presence of an accompanying earth concentrating towards the other end of the fractionations.

"3. The crimson line belongs to alumina, but its full development requires certain precautions to be observed in the time and intensity of ignition, degree of exhaustion, or its absolute freedom from alkaline and other bodies carried down by precipitated alumina, and difficult to remove by washing; experience not having yet shown which of these precautions are essential to the full development of the crimson line and which are unessential.

"4. The earth alumina is a compound molecule, one of its constituent molecules giving the crimson line. According to this hypothesis alumina would be analogous to yttria."

Experiments on the Purification of Alumina.

Little or nothing being known as to the delicacy of the methods of separating aluminium and chromium, it seemed a matter of first importance to experiment on this subject and endeavour to prepare an alumina which should represent the utmost attainable purity. A considerable quantity of commercial ammonia-alum was dissolved in water to a dilute solution, and caustic soda† added in sufficient quantity to re-dissolve nearly the whole of the precipitate. A little undissolved alumina, iron, &c., were left behind. The alkaline liquid was boiled for an hour and then filtered. On testing the precipitate a trace of chromium was detected.

The clear alkaline solution was saturated with chlorine gas till no more alumina fell down, and the liquor retained, after repeated agitation and rest, a strong chlorous odour. It was assumed that any chromium which might have escaped precipitation from the boiling soda solution would be oxidised and kept in solution as sodium chromate by the excess of chlorine. The precipitated alumina was filtered off, and well washed with hot water till chlorine was found to be absent from the washings.

This alumina was a second time dissolved in caustic soda, and the solution was well boiled. No precipitate came down. The clear solution was again submitted to the chlorine treatment, and the precipitated alumina was filtered and washed. A considerable quantity of alumina was prepared in this manner. It gave a good crimson line in its phosphorescent spectrum.

Separation of Alumina and Chromium.

It will be noticed that, in the above method of preparing alumina, I have assumed that the processes of separating alumina and chromium, (1) by boiling the alkaline solution and (2) by passing excess of chlorine through the alkaline solution, are accurate in the presence of an enormous excess of alumina. This, however, is an assumption which it is not safe to make, and accordingly I tried special experiments on each point.

1. *By Boiling the Alkaline Solution.*— Sulphate of alumina was mixed with standard solution of chrome alum in the proportion of 10,000 parts alumina and one part of chromic oxide. Caustic soda was added till the precipitate just re-dissolved, and the whole was boiled. A distinctly visible precipitate of a green colour came down. This was filtered, washed, and tested for chromium by fusion with nitre, &c. Every test showed chromium.

The same operation was repeated on a mixture containing one of chromic oxide and 50,000 of alumina. The results were equally conclusive. I have no doubt that, by this method, I could have separated a very much smaller quantity of chromium from alumina.

2. *By passing Chlorine through the Alkaline Solution.*—A mixture of sulphate of alumina and chrome alum in the proportion of 50,000 alumina to one of chromic oxide was mixed in the cold with excess of caustic soda, and the clear liquid supersaturated with chlorine gas and filtered. The filtrate from the alumina, which should contain all the chromium present in the form of sodium chromate, was supersaturated with hydrochloric acid and boiled till free from volatile chlorine compounds. Sodium sulphite was then added, and it was again boiled to reduce any chromic acid which might be present. Ammonia in excess was now added, and the whole was boiled; a very small precipitate fell down; it was filtered and washed. Chromium was easily detected in it by the usual tests, although the amount recovered was not so large as by process No. 1.

It may be objected that these methods are not so delicate as I suppose them to be—that a certain quantity of chromium always adheres to the alumina, and that when I add a trace more and then appear to recover it I do not recover that identical trace, but only that portion of the chromium which my addition has raised to the detection-point. This may be so; it is a rather unlikely phase of chemical reaction, but I do not see how it can be got over except by uniting several different methods of purification. Chemical analysis would scarcely deserve the name of a science if so strained an argument as the one above quoted were to be generally applicable.

3. *By Fractional Crystallisation of Ammonia-Alum.*—Ammonia-alum, found to be free from chromium by each of the above methods, was mixed with the 50,000th part of its weight of chrome alum and submitted to fractional

* *Roy. Soc. Proc.*, vol. xlii., pp. 25 to 31, Jan. 13, 1887; Chemical News, vol. lv., p. 25.

† Soda was used in preference to potash owing to the ease of getting the former alkali pure by oxidising metallic sodium.

crystallisation, the crystals from each dish being added to the mother-liquor from the crystals below them, the mixture re-dissolved and again allowed to crystallise.

In this way the crystals at each operation were lifted a step higher, whilst the mother-liquors were similarly degraded a step. Not many crystallisations were required to show which way the chromium travelled. The lowest mother-liquor gradually began to show colour, and after about thirty crystallisations abundance of chromium could be detected in the last mother-liquor, a considerably smaller quantity in the penultimate dish, and a trace in the antepenultimate. In crystals representing the higher fractions no chromium could be detected.

This method therefore proves that fractional crystallisation is as good a way as any for ridding alumina of traces of chromium, if, indeed, it is not the best way, inasmuch as the method is easily adopted on the large scale, whilst it is cumulative; for we cannot well apply to it the reasoning advanced against processes 1 and 2.

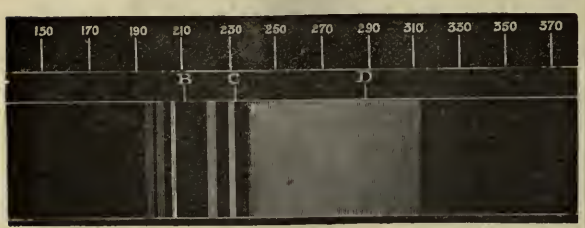
Preparation of Pure Alumina.

Alumina which had been doubly purified by processes 1 and 2 was converted into sulphate and mixed with the equivalent quantity of ammonium sulphate; re-distilled sulphuric acid and pure aqueous solution of ammonia being used. On evaporating the solution fine crystals of ammonia-alum were obtained. These were re-crystallised five times, dried, and kept as the stock material for future work.

Fractionation of Pure Alumina.

The ammonia-alum purified in the above manner* was now submitted to systematic fractionation by crystallisation in the way described above (process 3).† Tests in the radiant matter tube were from time to time taken with the products of each dish; a small quantity of the solution being removed and, after ignition of the contained alumina to a white heat, submitted to the induction spark in a high vacuum. At first the spectrum of the phosphorescent light was similar to the one already described,‡ consisting essentially of a sharp crimson double line, then a pair of fainter and rather nebulous red lines, and beyond these a continuous spectrum extending from red to green.

Fig. 1.



The Alumina Spectrum.

The accompanying cut (Fig. 1), borrowed from the paper already quoted, gives a fairly accurate representation of the spectrum, drawn to the $\frac{1}{\lambda^2}$ scale. The continuous portion of the spectrum is, however, shown a little too strong.

As fractionation proceeded the character of the phosphorescent spectrum given by the higher crystals underwent a remarkable modification. The continuous spectrum extending from about 236 to about 310 became fainter, and beneath it a system of sharp lines were visible. Further fractionation had the effect of lifting the continuous light as a veil and disclosing beneath it the new lines in greater and greater strength and sharpness, until finally they stood out with almost gas-like sharpness on a black background. As the continuous spectrum disappeared the crimson line at 20765 became fainter, as if continued fractionation would separate it from the new lines, but I have only once, almost by accident, succeeded in effecting this.

Approximate measurements of this new spectrum are given in the following table:—

Scale of spectroscope.	$\frac{1}{\lambda^2}$	Remarks.
10·220	2562	Centre of faint hazy band.
10·185	2613	Strong line.
10·140	2678	Less strong line.
10·04	2820	Faint line.
10·00	2877	Faint line.
9·935	2970	Stronger.
9·87	3061	Faint green, sharper on the edge nearest the blue.
9·8	3160	Centre of broad green band.
9·69	3312	Do. Do.
9·545	3506	Limiting edges of a nebulous green band.
9·5	3570	
9·07	4130	Centre of a band similar to last, but broader and more hazy.

Towards the lower end of the fractionations the spectrum of the phosphorescent alumina gave the crimson line, the faint red lines, and the continuous spectrum with great brilliancy. I have shown that when chromium is present it concentrates at the lower end, and it is toward this end that the old alumina spectrum is seen in greatest perfection. This is a strong argument in favour of M. de Boisbaudran's view that the red phosphorescence and crimson line are caused by the presence of traces of chromium in the alumina, and against my contention that alumina free from chromium gives the same appearance. On the other hand chemists will bear in mind the excessive precautions I took to secure absence of chromium; and it must also be remembered that when chromium was intentionally added it was readily removed by a few fractional crystallisations, being undetected in the fourth lowest dish. Here, however, my presumably chromium-free alum showed the crimson line in almost the highest dish after a hundred fractionations, whilst even the lowest dish did not contain a detectable trace of chromium.

But, whatever be the active agent in producing the crimson line spectrum, it is evident that the new line spectrum cannot be due to chromium; and before chemists acquiesce in M. de Boisbaudran's view, that chromium and not alumina produces the crimson line spectrum, the presence of chromium must be demonstrated in my high aluminas by an analytical test vastly more delicate than any which is now known to me.

I willingly admit that M. de Boisbaudran has shown that a little chromium acts as an intensifier to the old alumina spectrum, just as lime and other earths act towards the spectrum of samaria, and it is an important point gained in this difficult branch of spectroscopy. But my learned friend's contention is that the chromium is the active body ("matière active") and the alumina is merely a solid solvent ("dissolvant solide") or diluent. Were this the case alumina by itself should be incapable of giving the crimson line spectrum, whilst chromium should yield this spectrum when mixed with other solid solvents.

I think I have sufficiently proved that alumina without chromium gives the crimson line, and it remains therefore to be ascertained what is the effect of adding a little chromium to other solid solvents. Were the crimson line a chromium one it is not likely that alumina should be the only solid solvent for chromium capable of developing it. With samaria, for instance, we know that not only lime, but baryta, strontia, glucina, thoria, lanthana, magnesia, alumina, zinc, cadmium, lead, and other metallic sulphates bring out the characteristic samarium spectrum.

* To avoid periphrasis I shall in future call this *pure alum*.

† For brevity I will call the crystals end the *higher end*, and the mother-liquors the *lower end* of the fractionation.

‡ *Loc. cit.*, Fig. 1.

M. de Boisbaudron has examined the effect of adding chromium to oxide of gallium.* He now finds the spectrum to consist of a sharp red line and a wide nebulous band. The red line is sufficiently faint for it to have been altogether missed by its discoverer when the announcement of the Ga and Cr spectrum was made in February,† so it cannot be called a very strong line. The wave-length is given as about 6897 to 6898 $\left(=\frac{1}{\lambda^2}\ 2102\right)$, a point on the spectrum close to the solar line B, and very far from the alumina crimson line which occurs at about—

$$\lambda\ 6940 = \frac{1}{\lambda^2}\ 2076.$$

Considering the close chemical analogy between aluminium and gallium it is not surprising that there is a distant resemblance between their two spectra.

For my part I have taken glucina, magnesia, lime, oxide of zinc, and other similar bodies, have added various proportions of chromic oxide to them, and have tried heating with and without sulphuric acid. The mixture has been raised to different temperatures from cherry-red to full white, and in no single case did I see any sharp red line. The general character of the phosphorescence was reddish orange, the spectrum being almost continuous, with the extreme red and blue ends obliterated. The amount cut off, and the relative intensities of the orange, yellow, and green portions, differed in each case, causing the superficial colour to vary.

Postscript, August 11th, 1887.

For some months past I have been quietly experimenting and writing the above paper with the intention of sending it to a scientific Society at the close of the vacation, when on Monday last, Aug. 9th, the *Comptes Rendus* of the sitting of the *Académie des Sciences* for Aug. 1 came to hand. In it I see that M. de Boisbaudran read a paper on some "New Fluorescences with Well Defined Spectral Rays." This leaves me no option but to publish instantly as far as I have written, and at the same time to give a brief account of some other results I have obtained—results which I had intended should form the basis of an additional paper.

M. de Boisbaudran prepares a mixture of alumina with 2 per cent of samaria and converts them into sulphates. After heating to a temperature between the melting-points of copper and silver, this mixture, in the radiant matter tube, gives a feeble fluorescence, the spectrum of which resembles the well-known samarium-aluminium spectrum, which I described in June, 1885.‡

I reproduce here the drawing of the aluminium-samarium spectrum which illustrated that paper.

After energetically calcining his aluminium-samarium mixture before the blowpipe, M. de Boisbaudran finds its spectroscopic appearance to entirely alter. Instead of consisting of three nebulous bands, it now consists of a number of sharp rays "which form three groups corresponding respectively to each of the above described three diffused bands, but being refrangible."

I have only had time to prepare a few mixtures of aluminium and samarium sulphates, and test their phosphorescent spectra after calcination at different temperatures. With 2 per cent of samaria, ignited at a low temperature, the phosphorescent spectrum is that of samaria slightly modified by the presence of alumina, as I described and figured it two years ago. After ignition at a white heat the samarium spectrum disappears, and is replaced by a sharp line spectrum as described by M. de Boisbaudran.

Contrary, however, to what this distinguished chemist says, I do not see between this spectrum and the one it has replaced any such resemblance which would enable me to assent to his opinion that the groups correspond, "except that those of the line spectra are less refrangible." In my opinion, as far as I can form one by careful scrutiny of the spectra without actual measurements, the new aluminium-samarium high temperature spectrum is very similar to that which I have described in the former part of this paper, as yielded by pure alumina after intense ignition.

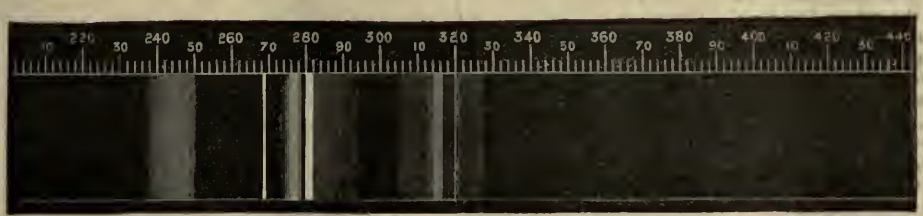
That this explanation is probable may be seen by the following argument. Both samarium sulphate* and aluminium sulphate will stand a red heat without the sulphuric acid being driven off. Aluminium sulphate does not phosphoresce, but samarium sulphate does. The mixture therefore gives the samarium spectrum.†

Now ignite the mixed sulphates to the highest blowpipe temperature. Both are decomposed, leaving a mixture of samaria and alumina. Samaria by itself gives practically no phosphorescent spectrum, but alumina ignited to a very high temperature gives the new line spectrum I have already described. The mixture, therefore, might reasonably be expected to give the line spectrum of alumina, and this is what comparison, in the absence of measurement, leads me to believe has occurred. I have scarcely had time to verify this by measurement in my large spectroscope, but next week I hope to publish drawings of the different spectra carefully mapped to scale, so that anyone will be able to form his own opinion of their concordance or disagreement.

It may be argued that the "pure" alum used for fractionation contained a little samarium. In my anxiety to keep out chromium I might have overlooked the former earth. I have, therefore, tried some experiments to see which way samarium travels during fractional crystallisation, if it happens to be present in alum.

Some of my pure alum was mixed with a very little impure samarium sulphate, and fractionally crystallised about fifteen times. Nearly the whole of the samarium (with accompanying didymium) concentrated in the lowest mother-liquor, the last dish but one containing scarcely any samarium, whilst none could be detected in any of the higher crystallisations either chemically or in the

Fig. 2.



* *Comptes Rendus*, vol. civ., p. 1584, June 6th, 1887.
† *Ibid.*, vol. civ., p. 333, February 7th, 1887.
‡ "Aluminium and samarium give a spectrum resembling the corresponding calcium one as to the red and double orange, but having a very broad, somewhat faint, green band, with a black division in the middle occupying the position of the bright green band of calcium-samarium."—"On Radiant Matter Spectroscopy. Part II.—Samarium. By William Crookes, F.R.S., V.P.C.S. Read before the Royal Society, June 18, 1885." *Phil. Trans.*, 1885, Part 2, p. 712.

On Radiant Matter Spectroscopy. Part 2,—Samarium." *Loc. cit.*, par. 137.
† *Loc. cit.*, par. 144.

radiant matter tube. As the new line spectrum of alumina is best seen with the crystals at the higher end, whilst samarium rapidly settles to the lowest end, it is evident that a far less number than the hundred fractionations actually effected would remove the uttermost trace of samarium from that fraction of alumina which gave the line spectrum.

ON SHARP LINE SPECTRA OF PHOSPHORESCENT YTTRIA AND LANTHANA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

In a paper on Yttria published in 1883* I showed that pure yttria precipitated by ammonia from the sulphate, then dried at a temperature below redness and tested in the radiant-matter tube, did not phosphoresce in the slightest degree. The remarkable results which I have lately obtained with intensely ignited alumina induced me to examine the behaviour of other earths after being submitted to intense ignition.

Precipitated yttria ignited to a full white heat phosphoresces with great brilliancy with a clear yellow light, and gives in the radiant-matter tube a very beautiful spectrum of sharp lines. In the red there are two groups of lines, followed by a very prominent orange line at about $\frac{1}{\lambda^2}$ 255. Then come several fainter lines and an intensely brilliant citron line, occupying the position of the well-known citron band given by yttrium sulphate.† On examination with a very high power and narrow slit this is seen to be double, the two components being a very little closer than the D lines; indeed so closely does this citron line resemble that of sodium, that nothing short of seeing the two side by side in different parts of the same spectrum will convince anyone who sees the citron line for the first time that he is not looking at the sodium line. After the citron line comes a faint sage-green band and two brilliant groups of green lines. Then comes a comparatively clear dark space, and finally there is a wide blue band composed of numerous fine lines, and a similar bundle of fine lines in the violet.

A specimen of white lanthana prepared by myself some years ago, but of which the history is obscure, on being strongly calcined, became of a fawn colour. When examined in the radiant matter tube this earth phosphoresced of a superficial yellow colour, giving a remarkalby brilliant spectrum. In the red is a fine line very similar to the alumina line, quite sharp, but nearer the position of the C line of hydrogen. Next follow a hazy pair of red lines, the first of which appears compound; then come a nebulous pair of green lines, and lastly another widely separated pair of a bluish green colour, the first of which is of extreme brilliancy.

Treated in the same manner samaria, ytterbia, erbia, and niobic acid have given no striking results; but the research is in too premature a state to permit me to say more in this hurried note.

The Alums formed by Selenic Acid.—C. Fabre.—The author has prepared the selenic aluminium alums of potassium, sodium, cæsium, rubidium, thallium, ammonium, ethylamine, diethylamine, triethylamine, methylamine, dimethylamine, and propylamine, all corresponding to the general formula $Al_2O_3,3SeO_3 + MOSeO_3 + 24HO$. A mixture of the *violet* solution of chromium seleniate gives well-crystallised alums with potassium, sodium, cæsium, rubidium, thallium, ammonium, ethylamine, and propylamine seleniates.—*Comptes Rendus*, Vol. cv., No. 2.

* The Bakerian Lecture, "On Radiant Matter Spectroscopy: The Detection and Wide Distribution of Yttrium." *Phil. Trans.*, 1883, Part 2, par. 75.

† *Loc. cit.*, pars. 71, 72

ON THE FORMATION OF NITRITES DURING NITRIFICATION OF AMMONIACAL SOLUTIONS.

By J. M. H. MUNRO, D.Sc.,
College of Agriculture, Downton, Salisbury.

In the great majority of the experiments on nitrification in artificial solutions which have been made and published by Warington* and by myself† in this country, and by various observers on the Continent, the earlier stages of the process are marked by the formation of a variable quantity of *nitrite*. So generally is this the case that, when observing the nitrification of ammonia added to well waters already containing nitrate, the production of the first recognisable trace of *nitrite* was always tested for by me to mark the commencement of the nitrification process.‡ It is true that in special cases complete oxidation of ammonia to nitrate may be observed without nitrite appearing at any stage of the process, and we can generally secure this result by attending to the conditions pointed out by Warington and confirmed in my own experiments. These are extreme dilution of the ammoniacal solution, low temperature, presence of the nitrifying ferment or seed in considerable quantity and active condition, shallow layers of liquid, and free admission of air. Nitrites (unless formed by reduction) are not often met with in natural waters, because these conditions of a purely nitric fermentation are generally present; they *are* almost always found in experiments with artificial solutions, because these conditions are not all present.§ In general the formation of nitrite begins after the period of quiescence or incubation which usually precedes nitrification, increases up to a certain period, and then *in most cases* the nitrite present diminishes by degrees as fast as it undergoes conversion into nitrate. Sometimes, however, the nitrite persists without alteration for months, and then may suddenly undergo rapid conversion into nitrate: the cause of this capricious behaviour is not known.

It has been generally held that the nitrite thus formed (whether by the agency of a special organism or by that which forms also nitrate) arises from direct but incomplete oxidation of the ammonia, and that it represents in fact a mere passing phase of the transformation of ammonia into nitrate.

But it has also been suggested that the nitrite may be formed by a secondary action, viz., reduction of the nitrate at first formed, instead of by oxidation of ammonia. Denitrification is a process very easily brought about under a great variety of circumstances, and by the agency of microbes of many different kinds, and it very often takes the form of reduction of the nitrate to nitrite as a first stage. The mere exposure to unfiltered air of a liquid containing at once fermentable organic matter and a nitrate is almost certain to be followed in a day or two by the appearance of nitrite formed by reduction.‖ Gayon and Dupetit have shown that the various microbes which have the power to effect this change do so by causing oxidation of the organic matter at the expense of the oxygen of the nitrate, when they multiply in liquids not freely exposed to the air. Hence the suggestion that the nitrifying organism itself, after developing at the bottom of a nitrifying solution, may acquire a character similar to that of the denitrifying bacteria, and may cause the nitrate which has already been formed under its agency to part with oxygen which either oxidises organic carbon or more ammonia to nitrite. In the former case all the nitrite would be produced by a secondary reduction of the nitrate; in the latter case, three-fourths

* *Chem. Soc. Journ. Trans.*, 1878, p. 44; 1879, p. 429; 1884, p. 637.
† *Ibid.*, 1886, p. 632.
‡ *Loc. cit.*, p. 663.
§ Munro, *loc. cit.*, p. 679.
‖ Gayon and Dupetit, in abstract in *Chem. Soc. Journ.*, 1886 (Abs.), p. 823; Munro, *loc. cit.*, p. 667, *et seq.*

by secondary reduction of nitrate, one-fourth by direct oxidation by ammonia.

Messrs. Gayon and Dupetit, who have suggested that the nitrite observed during nitrification is really formed by reduction of nitrate, leave it to be inferred that in this case the oxygen given up by the nitrate goes to oxidise organic matter which they assume to be present in the solution.* But if it be shown that the nitrite developed during nitrification is formed in the absence of oxidisable organic matter, then it is not produced by such a reduction of nitrate as that suggested by Gayon and Dupetit, as the work either of foreign organisms or of the modified nitrifying organism itself; and if also it be shown that ammonia is not oxidised by reduction of nitrate, then it will follow that the nitrite produced in nitrification is due to direct oxidation of ammonia by atmospheric oxygen. The first half of this statement has been demonstrated in my former paper;† the experiments which are now to be described were instituted last year in order to throw light on both points, but more especially the latter. If the nitrifying organism forms nitrite by direct oxidation of ammonia only, it is plain that no more nitrite can be formed than corresponds to the ammonia present; if, on the other hand, it has the power of reducing already-formed nitrate in order to oxidise the ammonia, producing nitrite from both, then if nitrification be carried on in a liquid to which nitrate has been purposely added, there is no reason why the nitrite produced should not exceed in quantity that producible from the ammonia present,—in fact it may be four times this quantity, if all the ammonia is oxidised at the expense of the nitrate, thus—

$$NH_3+3KNO_3=HNO_2+3KNO_2+H_2O.$$

A solution was therefore prepared, containing ammonium chloride with 3 equivalents of potassium nitrate, some calcium carbonate as salifiable base, and a little soil to supply the nitrifying organism; the quantity of nitrite formed in this was determined from time to time, in order to see whether it was at any time more than equivalent to the ammonia salt added.

A second solution, made up for comparison with this, resembled it in every respect save that the potassium nitrate was omitted.

A third solution contained the potassium nitrate and soil only, the object being to show that the nitrate was not reduced to nitrite by soil alone under the circumstances of the experiments.

Solution A contained 85 c.c. standard ammonium chloride (= 85 m.grms. NH_3 = 70 m.grms. N), 1·515 grms. potassium nitrate (= 210 m.grms. N), and 500 m.grms. calcium carbonate, made up to 700 c.c. with distilled water.

Solution B, the same, without the potassium nitrate.

Solution C, 1·515 grms. potassium nitrate in 700 c.c. distilled water.

The solutions were placed in three similar stoppered bottles, which they more than half filled, and a little soil from a recently nitrified solution was washed, divided into 3 parts, and added to each. The layer of liquid in each bottle was 5 inches deep. The solutions were made up on June 25th, 1886, and kept in the dark in a cupboard in the Laboratory. The conditions were very favourable to production of nitrite, since the solutions were strong, the quantity of seed small, and the air in the bottle could only be renewed when the stoppers were removed in order to test the liquids—not more than fifteen times in the course of twelve months.

The results of the periodical testings of these solutions are summarised in the following Table:—

Solution B.—NH_4Cl alone.

Date.	Interval.	5 c.c. tested with metaphenylen diamine gave	10 c.c. deco-lourised c.c. permanganate.	M.grms. N as nitrite in 700 c.c.
1886.				
June 25	—	No colour	Made up	0
,, 26	1 day	,,	—	—
,, 28	3 days	Faint straw yellow	—	—
July 1	6 ,,	Yellow	—	—
,, 5	10 ,,	Bright yellow	—	—
,, 15	20 ,,	Deep amber	0·5	3·06
,, 22	27 ,,	Very deep amber	1·35	8 27
,, 29	34 ,,	,,	1·85	11·33
Aug. 6	42 ,,	Red	2·25	13·78
,, 14	50 ,,	,,	3·70	22·66
Oct. 18	115 ,,	,,	10·40	63·70
Nov. 11	139 ,,	,,	10·70	65·53
Dec. 17	175 ,,	,,	10·00	61·25
1887.				
Mar. 7	255 ,,	No colour	None	None
June 24	364 ,,	,,	,,	,,

Solution A.—$NH_4Cl+3KNO_3$.

1886.				
June 25	—	No colour	—	0
,, 26	1 day	,,	—	—
,, 28	3 days	Straw-yellow	—	—
July 1	6 ,,	Bright yellow	—	—
,, 5	10 ,,	Deep yellow	—	—
,, 15	20 ,,	Deep amber	0·95	5·81
,, 22	27 ,,	Red	2·45	15·00
,, 29	34 ,,	,,	3·80	23·27
Aug. 6	42 ,,	,,	4·7	28·79
,, 14	50 ,,	,,	5·2	31·85
Oct. 18	115 ,,	,,	9·6	58·80
Nov. 11	139 ,,	,,	10·4	63·70
Dec. 17	175 ,,	,,	10·5	64·31
1887.				
Mar. 7	255 ,,	,,	8·7	53·28
June 24	364 ,,	No colour	None	None.

Of Solution C, which contained the potassium nitrate and soil only, it is sufficient to say that a trace of nitrite developed on the third day, and disappeared between the sixth and tenth days; during the remainder of the 364 days no trace of nitrite appeared. The trace of nitrite at first formed evidently arose from oxidation of the trace of ammonia contained in the distilled water (ordinary distilled water was used, giving at first a pale amber with Nessler's test, but no colour on the sixth day); it almost immediately passed into nitrate. It is evident that no formation of nitrite by reduction of nitrate took place in this solution throughout the experiment.

Solutions A and B, it will be seen, behaved almost alike. Nitrite began to be developed immediately, and gradually increased in quantity during four or five months after making up the solutions, when about 65 m.grms. out of the 70 m.grms. of N originally added as ammonium chloride appeared as nitrite. Tested at intervals with Nessler's solution, No. 1 was found to have lost nearly all its ammonia on October 18th, and No. 2 on November 11th; on March 7th both were free from ammonia. The nitrite persisted through the winter in both solutions, but suffered complete conversion into nitrate during the following spring. In both solutions, therefore, the ammonia was almost completely converted into nitrite before the commencement of the nitric fermentation, and the

* "Dans les recherches sur les variations des propriétés du ferment nitrique, M. Warington a vu se former de l'acide nitreux au sein de ses cultures, des que l'épaisseur de la couche liquide devenait un peu grande. On peut expliquer ce fait en admettant que l'oxydation par le même ferment nitrique a fait en deux périodes, dont la première donnerait précisément l'acide nitreux, ou en supposant, avec M. Duclaux, que deux ferments, l'un nitreux, l'autre nitrique, s'étaient développés simultanement. Nous pensons plus volontiers que les nitrites étaient dus, non à une oxydation partielle de la matière organique, mais à une désoxydation incomplète de l'acide nitrique déjà forme, soit que le ferment nitrique de M. Warington ne fut pas pur, soit, ce qui est moins probable, qu'il eut acquis des propriétés reductrices, en vivant en profondeur, hors de l'oxygène de l'air."—*Recherches sur la Reduction des Nitrates par les infiniment petits*, pp. 4, 5, Gayon et Dupetit.

† *Loc. cit.*, p. 651, *et seq.*

nitrate purposely added to Solution A was apparently without influence on this conversion. At no time did the N as nitrite present in this solution exceed that originally added as ammonium chloride. It appears therefore that the ammonia was in both solutions oxidised to nitrite by oxygen obtained from the air, and that none of the nitrate added to Solution A was reduced to nitrite for the purpose of oxidising either ammonia or the small quantity of organic matter present in the soil. That the conditions of the experiment were favourable to nitrite formation is evident from the fact that nearly all the ammoniacal nitrogen was converted into nitrite before the formation of nitrate commenced.

It may be further noted that, whereas the oxidation of organic matter by oxygen disengaged during reduction of nitrate has been shown, both in theory and fact, by Gayon and Dupetit, to result in the evolution of heat, no such production of heat appears to warrant the possibility of nitrite formation by simultaneous reduction of nitrate and oxidation of ammonia. The equation already given indicates rather an absorption,—that is to say, much more heat is absorbed by the decomposition of a molecule of ammonia, and the reduction of three molecules of nitrate to nitrite, than is evolved by the formation of one molecule of water, and one molecule of nitrous acid, and the saturation of the latter by a base.

The conclusion arrived at is that nitrite is formed during the nitrification of ammoniacal solutions by direct oxidation of ammonia, and without any reduction of already-formed nitrate.

ON A MODIFICATION OF THE FERRIC CHLORIDE CELL.

By THOMAS MOORE.

The usual form of the ferric chloride cell consists of an amalgamated zinc plate or cylinder in dilute sulphuric acid, and a carbon in the porous cell, with a strong acid solution of ferric chloride as a depolariser. When first made up it yields a powerful current, but owing to the rapid reduction to ferrous chloride, and the comparatively slow absorption of oxygen, the strength rapidly decreases. Mr. Warren has, however, made an immense improvement on this by using bromine with the ferric chloride. But the use of bromine is rather expensive; for although it is possible to recover it by the addition of a little bleaching-powder, still there is always a considerable loss, and the operation is rather disagreeable. If in place of bromine we substitute a few crystals of potassic chlorate and a little hydrochloric acid, the regeneration of the ferric salt is equally perfect.

$$KClO_3+6HCl+3Fe_2Cl_4=KCl+3Fe_2Cl_6+3H_2O.$$

If to this solution a very small quantity of bromine is added it will be easily understood that, so long as there is any potassic chlorate left, the small amount of bromine will be capable of regenerating an unlimited amount of the iron salt.

One part of potassic chlorate is equal to nearly 4 parts of bromine in regenerative power, and, moreover, as as potassic chlorate is quoted at 1s. per lb. and bromine at 4s. per lb., the advantages to be obtained are obvious. When the battery is being actively employed little or no annoyance is caused by the fumes, but in all cases it is best to place it where they can do no harm. Of course the chlorate may be employed with chromic acid, but the results are rather unfavourable.

Potassic permanganate, also, makes an excellent depolariser; and an exceedingly compact and handy little battery—especially suited for intermittent currents, electric bells, &c.—is made by placing a carbon and a zinc plate in a strong solution of the permanganate and ammonic chloride.

It is also interesting to note that exhausted Leclanché cells may be regenerated to a great extent by pouring into the porous cell a strong, warm, and slightly acid solution of the permanganate.

Erdington, July 30, 1887.

THE DETECTION OF CERTAIN VOLATILE HYDROCARBONS IN METHYLIC, AMYLIC, AND OTHER ALCOHOLS.

By H. N. WARREN, Research Analyst.

The following reaction was observed during the analysis of wood naphtha, which having been saturated with anhydrous calcium chloride, in order to retain the methylic alcohol, was distilled, by means of the water-bath, at a temperature of 212° F.

The volatile products collected thereby were afterwards separated by the usual method of fractional distillation, according to their different boiling-points. Among the first products to collect in the receiver was a volatile ethereal liquid, possessed of a boiling-point between 160° to 180° F. On treating the same with caustic soda it was observed, after the lapse of a few minutes, to strike a magnificent blood-red tint. Other alkalies were simultaneously tried: among these baryta, in admixture with a few drops of caustic soda, behaved most successfully, producing immediately a deep blood-red solution, even in very dilute solutions, and of remarkable stability. The same substance was afterwards detected in several samples of petroleum spirit possessed of low boiling-point; similarly also in samples of methylic, amylic, and other alcohols; also during the decomposition of coal-gas by means of chlorine. The product, on account of its low boiling-point, presents considerable difficulty of obtaining it pure, and has hitherto not been pursued further, but would undoubtedly prove a valuable dye for oils, provided it were mixable with the same.

THE SEPARATION OF NICKEL AND COBALT FROM IRON.

By J. B. MACKINTOSH.

As all chemists know, the separation of these metals is, at best, a long and tiresome task. It is generally assumed that two or at most three precipitations of the iron as basic acetate, or as hydrate by ammonia, are sufficient to effect a perfect separation, thus obtaining all the nickel and cobalt in the filtrates. I have found, however, in cases where there is a comparatively large amount of these metals present, as in most meteoric irons, that it is sometimes necessary to repeat the precipitation five or six times, or even oftener, before the filtrates cease to react for nickel and cobalt. In the analysis of one meteoric iron I noticed the very interesting fact that, after all the nickel had been removed, cobalt still remained with the iron, although the amount of cobalt in the sample was not more than one-tenth that of the nickel. At the time when this was noticed the colour of the filtrate on concentration was pink, having previously been green; if I remember correctly, this took place at about the sixth time of precipitation.

The probable reason for the difficulty seems to be that the nickel and cobalt become partially peroxidised, and, possibly, in the case of cobalt, that some of the ammonio-cobalt bases are formed, which are either rather insoluble, or are decomposed, with formation of peroxide, upon boiling.

In order to decrease the time and the number of operations necessary, I tried the old method of precipitation of

all three metals from the boiling solution with ammonium sulphide, with subsequent treatment with hydrochloric acid. I thus obtain two portions, the precipitate containing nearly all the cobalt and nickel with very little iron, and the solution containing nearly all the iron with very little nickel and cobalt; both these portions are then treated separately in the usual way by precipitation of the iron, as basic acetate, and a perfect separation may be much more readily obtained than if the solution had been treated directly without this preliminary concentration.

I tested this method on two meteoric irons which I have recently analysed.* and determined the amounts of combined nickel and cobalt found in the two portions after one precipitation as sulphides, and also after three such precipitations. It is to be noted that these operations take very little time, as the precipitated sulphides of nickel and cobalt are easily filtered and washed, and also that the bulk of solutions treated is very small, so that the time occupied by these three precipitations will hardly exceed that occupied by one basic acetate precipitation, and certainly will not when the time necessary for the concentration of the filtrate is taken into consideration. The results obtained are as follows :—

Precipitation of the Boiling Solution with Ammonium Sulphide and Subsequent Solution in Dilute Hydrochloric Acid.

	Total Ni+Co present.	Fe present.	Per cent Ni+Co. In precipitate.	In filtrate.
One precipitation ..	0·0956	1·0266	920·8 p.c.	7·92 p.c.
Three precipitations	0·1248	0·6021	96·32	3·68

In the first case the nickel and cobalt amount to 8·52 per cent of the total weight of metals, and in the second case to 17·17 per cent.—*School of Mines Quarterly*, July, 1887.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.†

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science
Member of the Academy of Natural Sciences, Philadelphia;
of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 56).

Extract (3), *the Green Part of the Leaf.*

THE residual powder from the petroleum spirit maceration was thoroughly dried, and again placed in the percolator. It was treated with Squibbs's stronger ether. The *extract* was a deep-green coloured liquid and fluorescent. The reaction was slightly acid. Alcohol, benzol, and petroleum spirit added to the *ethereal extract* did not cause a precipitation. An amorphous and green-coloured residue was obtained on evaporating the *extract*. The amount of total solids was estimated from a definite volume of the *extract*, which was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C.	1·25 of solids.
,, ,, ,, 110° C.	1·14 ,,
	0·11 of loss.

The *ethereal residue* was brought into a state of fine division and treated with water. The amount of total solids soluble in ether and water was 0·34 per cent. The aqueous extract was neutral in reaction. It was faintly coloured and slightly bitter to the taste. It was not coloured by iron salts nor precipitated with alum and gelatin solution, showing absence of gallic acid or tannin. Copper solutions were not reduced, indicating absence of glucosides, though the precaution was observed of boiling the aqueous extract with acid and rendering alkaline before adding the copper solution. The aqueous extract was agitated with acetic ether and a distinctly crystalline residue separated. Under the microscope these crystals were white, needle-shaped, and arranged in bundles. They did not respond to tests for gallic acid. Potash solution formed a yellow mixture with the crystals. The colour was discharged by a drop of hydrochloric acid. Chloroform did not dissolve any substance from the *ethereal residue*. The *ethereal residue* was treated with acidulated water and tested negatively for alkaloids.

The *ethereal residue* insoluble in water was treated with alcohol. The amount of substances insoluble in water, and soluble in ether and alcohol, was 0·15 per cent. The alcoholic solution was evaporated, and the residue was crystalline in structure. Concentrated sulphuric acid imperfectly dissolved it, and gave a reddish-yellow colour reaction; acetic ether discoloured the solution. The alcoholic residue was insoluble in acetic ether, cold and boiling aqueous alkalies; soluble in chloroform. It saponified with alcoholic soda.

The amount of the *ethereal residue* insoluble in water and alcohol was 0·65 per cent. It was not soluble in alcoholic or aqueous soda. This would indicate a resin anhydride. Concentrated sulphuric acid gave no colour reaction with it; and a mixture of sulphuric acid and cane sugar dissolved the residue.

The *ethereal residue* on treating with cold ether was not entirely soluble in it. It was soluble in chloroform, benzol, and carbon disulphide; incompletely soluble in cold alcohol, and insoluble in amyl alcohol. The *ethereal residue* was treated with 95 per cent alcohol, in which it was slightly soluble. A turbidity formed in the alcoholic solution on adding lead acetate, ferric chloride, ammonium hydrate, and sulphuric acid; it did not clear up on warming. Hydrochloric acid made a muddy mixture with the alcoholic solution. The *ethereal residue* was not entirely soluble in acetic ether; the latter separated colouring matter from it. The *ethereal residue*, insoluble in acetic ether and freed from colouring matter (chlorophyll), was a resinous substance. It melted at 80° C. The resin was boiled with absolute alcohol, and on throwing the alcoholic solution into cold water it was precipitated as a white cloud. It was not saponified.

Extract (4), *Yellow Base of Leaf.*

The residual powder from the petroleum spirit maceration was dried and extracted with stronger ether. The *ether extract* was a turbid yellow liquid, slightly acid in reaction. On evaporating the *ethereal extract* at the ordinary temperature a reddish-yellow granular solid remained. It melted at 79° C. For the determination of total solids extracted, a definite volume of the *extract* was evaporated, dried, and weighed.

I.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C.	1·7 of solids.
,, ,, ,, 110° C.	1·7 ,,
	0·0 of loss.

The *ethereal residue* was treated successively with distilled water, alcohol, and ether.

II.

Substances soluble in ether and water ..	0·8 per cent
,, ,, ,, alcohol ..	0·4 ,,
,, insoluble in water and alcohol ..	0·5 ,,
,, ,, ,, Total solids ..	1·7 ,,

The aqueous extract gave a neutral reaction with litmus. Negative results followed examination for tannin, gallic

* *American Journal of Science*, March, 1887, pp. 225, 232.
† Reprinted from the *Transactions of the American Philosophical Society.*

acid, glucosides, alkaloids, and any compounds containing nitrogen.

The *ethereal residue* (the *residue* insoluble in water) was an opaque reddish-yellow coloured substance, and was identified as a resin. It melted at 79° C. It was insoluble in ether, benzol, chloroform, and acetic ether; incompletely soluble in cold absolute alcohol, amyl alcohol, carbon disulphide, and oil of turpentine. It was soluble in aqueous and alcoholic soda. On boiling with them, it was saponified. Concentrated sulphuric acid dissolved the resin and coloured it a yellowish brown. Chloroform formed a turbid mixture with the acid solution. The action of strong nitric acid on the resin was slow. The resin was incompletely soluble in 95 per cent alcohol. Lead acetate gave a cloudiness with the alcoholic solution which increased on boiling. Ferric chloride thickened the alcoholic solution, and on boiling it gave a yellow precipitate which was insoluble in acids, alkalies, absolute alcohol, and acetic ether. The chloroform extract gave no colouration with bromine solution.

(To be continued).

OBITUARY.

LAURENT GUILLAUME DE KONINCK.

On July 17th died Laurent Guillaume de Koninck, formerly, for close upon thirty years, Professor at the University of Liege. He was born in 1809 at Louvain, where he studied Medicine and the Natural Sciences, and where he graduated as Doctor of Medicine.

In 1835 he was appointed Teacher of Technical Chemistry at the University of Ghent. In 1847 he accepted the Chair of Palæontology and Organic Chemistry at Liege, which he held until his resignation in 1876.

His palæontological researches are recognised as being of very high merit, his last work, "Faune du Calcaire Carbonifère de la Belgique," being unfortunately not yet completed.

Among his chemical labours we notice his researches on salicine, phloridzine, populine, and potassium sulphocarbamylate. In 1839 he brought out his "Elements de Chimie Inorganique," in 1865 a "Resumé de la Theorie des Types," and in 1867 "Tableaux des Principales Series des Composés Organiques."

The deceased was, up to his death, one of the editors of the *Revue Universelle des Mines et de la Metallurgie.*

The interment of the departed *savant* took place on July 19th, in presence of representatives of the Government and the most eminent men of Science in Belgium.

CORRESPONDENCE.

ANALYSIS OF VINEGAR.

To the Editor of the Chemical News.

Sir,—Since the preparation of my article upon "Analysis of Vinegar," which you published in Chemical News, vol. lvi., p. 3, I have devised a simple form of tube for use by tradespeople in testing the acid strength of their vinegar in percentages of monohydrated acetic acid. As illustrated by the accompanying cut, it consists simply of a glass tube having a bore of about $\frac{3}{8}$ inch, closed at one end, and long enough to be graduated in the following manner. At the height of 6 c.c. from the closed end it is to be marked o per cent. The space below bears the inscription "Fill with the Vinegar to be tested." Above this mark it is to be graduated for each c.c. up to 10 c.c., with subdivision into tenths. Only "per cent" is to be inscribed in place of the c.c.'s usual upon a burette.

For use, the tube is to be carefully filled with the vinegar up to exactly the o per cent graduation mark. One or two drops only of a tincture of phthalein are to be added, and a normal solution of caustic soda then gradually added, with a thorough mixing of the contents of the tube by closing its mouth by a finger and inverting it after each

addition, till at last a single drop of the soda changes the colour to a permanent pink. The level at which the contents then stands upon the graduation of the tube will indicate the acid strength of the sample of vinegar in per cents and tenths of monohydrated acetic acid with all the accuracy necessary for trade purposes.—I am, &c.,

Bennett F. Davenport.

161, Tremont Street, Boston, Mass.,
July 20, 1887.

MARKING WEIGHED PORCELAIN VESSELS.

To the Editor of the Chemical News.

Sir,—I have found the following simple method of much service, and, not having seen it published, I venture to communicate it. Any desired letters or figures are written on the porcelain with a diamond, then a little platinic

chloride solution is smeared over them, and, after being allowed to become almost dry, is *wiped* (not *washed*) off. On igniting the article so treated the figures stand clearly out, marked in metallic platinum.—I am, &c.,

BERTRAM BLOUNT.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 2, July 11, 1887.

Formation-Heat of Hydrogen Telluride.— M. Berthelot and Ch. Fabre.— Hydrogen telluride cannot be easily obtained by means of zinc or iron tellurides. If these bodies are pure acids do not attack upon them, and if they contain an excess of metal the gas evolved contains much free hydrogen. Magnesium telluride gives the best results. It is obtained by causing the vapour of tellurium in excess to act upon magnesium heated in a current of pure dry hydrogen. We obtain thus a white flocculent body, very unstable in the air, and which, on treatment with dilute hydrochloric acid, gives off abundance of hydrogen telluride. The gas thus obtained is entirely absorbed by potassa. If preserved over mercury it is spontaneously decomposed in a few hours, even in the dark. In contact with moist air the decomposition is immediate. The odour of hydrogen telluride differs notably from that of the corresponding sulphide and selenide. Its action upon the animal system is not nearly so insupportable as that of hydrogen selenide. Hydrogen telluride dissolves rapidly in alkaline solutions. If these are concentrated we obtain crystalline tellurides, white or colourless, giving in *pure* water colourless solutions, but a trace of oxygen gives the liquid a fine violet tint, and an excess of oxygen throws down free tellurium. The formation of hydrogen telluride from its elements takes place with absorption of heat. In one and the same family of simple bodies combined with hydrogen the heat of molecular combination diminishes progressively, and even becomes negative as the molecular weight increases.

Crystalline Form of Quercine.—C. Friedel.

The Klinorhombic Form and the Optical Characters of Prismatic Arsenious Acid.— M. Des Cloizeaux.—These two memoirs do not admit of useful abstraction.

A New Method of Preparing Acetyl-cyanacetic Ether.—MM. Haller and Hold.—The authors dissolve 23 grms. cyanacetic ether in its weight of absolute alcohol. and add a solution of 4·6 grms. of sodium in 60 grms. of the same alcohol. To this mixture are then added 8 grms. acetyl chloride in 20 grms. of ether, and the whole is heated until it no longer has an alkaline reaction. We evaporate then in the water-bath, take up the residue in water, shake with ether to dissolve the ethyl cyanacetate which has not entered into reaction, and then decant. The aqueous solution is supersaturated with sulphuric acid and exhausted with ether. The ethereal liquid distilled leaves the cyanic compound as a residue.

Osmotic Equilibrium and the Concentration of Solutions by Gravity.—MM. Gouy and Chaperon.— This paper does not admit of useful abstraction.

Study of the Reactions of the Vanadates from an Analytical Point of View.— Ad. Carnot.— Already inserted.

Rectification of Industrial "Phlegmes." — L. Godefroy.—The simultaneous use of lime and chloride of lime constitutes an efficacious, simple, and cheap process for the purification of crude spirits.

Zeitschrift für Analytische Chemie. Vol. xxvi., Part 1.

The Reactions of the Albumens and their Chemical Detection in Physiological and Pathological Cases. —R. Palm.—The following are special reagents for the albumens not precipitating organic bases. (1) Ferric acetate, rendered previously basic by digestion with an excess of freshly precipitated ferric hydroxide in an alcoholic solution. If slightly heated with the solution in question, even the smallest traces of albumens are precipitated. (2) Alcoholic solution of cupric acetate; the precipitate obtained is dissolved in acetic or lactic acid, the solution mixed with a little soda-lye, and heated to boiling. If albumen is present in the copper precipitate immediate reduction ensues. (3) An alcoholic solution of basic lead acetate or of lead chloride. This reaction has the advantage, as compared with the two foregoing, that the precipitate is colourless, so that the presence of albumen in it can be further confirmed by the colour reaction with glacial acetic acid and sulphuric acid, according to Adamkiewicz. All these three reagents throw down albumens from the peptones, and the precipitate is insoluble in an excess of the precipitant. (4) Freshly precipitated lead hydroxide is slightly soluble in pure water, especialle with the aid of heat. This solution shows the slightest traces of albumens (1 part in 500,000), especially if a littly alcohol is added to the mixture.

The Gas Balance, an Apparatus for Determining the Specific Gravity of Gases.—F. Lux.—An illustrated paper.

Fire-damp Meter for Determining Methane in the Gases of Coal-Mines.— P. von Mertens.— This paper requires the four accompanying figures.

Gasoline Blast and Muffle Furnace.—W. Hoskins. —This memoir cannot be intelligibly reproduced without the accompanying illustration.

Novel Glass Apparatus.—Greiner and Friedrichs.— These appliancee include a double action washing- and absorption-bottle, a washing- or absorption-apparatus, to be charged with solid or liquid and solid absorbents, and glass cocks with oblique perforations.

Remark on Huss's Method for Determining Phosphorus in Iron and Steel.— P. Vorwerk.— This modification of the Sonnenschein process involves a source of error from the organic matters resulting from the solution in nitric acid, the action of which is not annulled by boiling for fifteen minutes, and by the addition of ammonium chloride. The results will, therefore, fall too low.

Filters with a Fatty Margin.— A. Gawalowski. — Certain precipitates creep up over the edge of the filter-paper. To prevent this the author saturates the margin of the paper with paraffin (free from ash), wax, or some other fat.

Analysis of Certain Caucasian Wines.—B. Tairoff. —No novel analytical procedure is described.

Apparatus for Electrolytic Determinations.—Dr. R. v. Malapert.—This memoir requires the accompanying figures.

A Modification of the Otto Acetometer. — W. Fresenius.—As indicator the author uses phenolphthalein, which has the advantage that a single drop is sufficient The new acetometer consists of a cylindrical glass tube, closed at the lower end, 12 m.m. wide and 17 to 18 c.m. long, having a mark at the point up to which it contains 5 c.c., and is graduated from there upwards in c.c. as far as 12. Each c.c. is again subdivided into fifths, so that $\frac{2}{10}$ c.c. can be read off and $\frac{1}{10}$ may be estimated.

Production of Iodide Coatings. — J. Schnauss (*Chemiker Zeitung*).— The author points out that the gypsum tablets used as supports by Haanel, Wheeler, and Lüdeking become dull and crumble away on heating. As a substitute he recommends plates of mica. For Casamajor's modifications see CHEMICAL NEWS.

New Applications of the Nitrometer.—A. H. Allen, G. Lunge, T. Bayley.—A conspectus of the views of these chemists, given in the Chemical News, the *Berichte*, in *Chemische Industrie*, and in the *Journal Soc. Chem. Industry*.

Apparatus for Determining the Heat of Combustion.— W. Alexejew.— An improved modification of the apparatus proposed by Fischer and Schwackhöfer. Modifications of Thomson's calorimeter have been proposed by Stohmann and Rechenberg.

Improvements in Short-arm Balances.— F. Sartorius.—The modifications refer to the adjustment of the knife-edges, and to the suspension of the scale pans (*Chemiker Zeitung*).

Evaporation-Nitch.—W. Hempel (*Berichte*) and C. M. Stuart (Chemical News).

Filter-press for Laboratory Use.— W. Hempel.— The author keeps in view that such appliances should admit of being easily cleansed. Hence he constructs all parts which come in contact with the liquid of glass, porcelain, or caoutchouc.

Preparation of Oxygen and of Hydrofluoric and Hydrofluosilicic Acid.— Iron instruments have been devised for this purpose by Hempel and Muencke.

Determination of Zinc.— G. Lösekann and Th. Meyer.—If a solution of zinc in hydrochloric or sulphuric acid, accurately neutralised with ammonia, is mixed with a sufficiency of sodium phosphate, there is formed a white voluminous precipitate of zinc-ammonium phosphate, which, if heated to a boil, is deposited in a granular-crystalline form. If the precipitate, after filtration, washing, and drying, is ignited over the blast-flame, it melts to a limpid fluid of zinc pyrophosphate, $Zn_2P_2O_7$. Ammonium sulphide produces no turbidity in the filtrate. The following conditions should be observed:—After adding excess of ammonia and sodium phosphate, hydrochloric or sulphuric acid should be dropped in until the reaction is amphoteric. Liquid and precipitate are heated to a boil, filtered after the lapse of six hours, and washed with hot water until the last washings do not show phosphoric acid if tested with molybdenum mixture. The precipitation may be directly effected in an accurately neutralised liquid (containing ammoniacal salt) by the addition of sodium phosphate. This method of operating is not recommended if much zinc is present, as the precipitate does not take a granular crystalline form. It is advisable to use a portion of the substance not containing more than 0·3 grm. of zinc. The quantity of solution of sodium phosphate added (1 : 10) should not exceed 50 c.c. As the melted zinc pyrophosphate often scatters itself in dust, it should be cooled and weighed in a covered crucible. The determination of zinc in presence of manganese cannot be effected in this manner. In presence of magnesia in a sulphuric solution, it succeeds perfectly (*Chemiker Zeitung*).

MISCELLANEOUS.

Royal Jubilee Exhibition, Manchester.— One of the most interesting exhibits in the chemical section of this Exhibition is that of Dr. Theodor Schuchardt, of Görlitz, in Germany, consisting as it does of an excellent collection of rare and new chemical preparations, especially those used in scientific, medical, pharmaceutical, photographic, and technical work. A large amount of time and labour must have been expended in order to bring before the public this proof of the great progress chemistry is making in her ever-extending relations with the different branches of Natural History. We here see 67 inorganic and 190 organic compounds which have never before been produced in such quantity, and at the same time in such a state of purity. The first section consists principally of the rare elements, and those compounds of other elements which may justly be called rare, considering the difficulties to be overcome in their manufacture. First among these we notice selenium and tellurium, both similar to sulphur in their chemical reactions, and found in very few minerals. The pure selenium is shown in very good hexagonal crystals, and the tellurium in the form of brilliant needles of metallic lustre. "Germanium," one of the newest elements discovered by Prof. Winkler, is also shown: up to the present time it has only been found in one mineral, and that a rare one, named "argyrodite," found at Freiberg; its chemical reactions are of great interest, its salts being of a very soluble character. Among the other metalloids exhibited by this firm we may mention a box containing large crystals of silicium, and brilliant leaf-shaped crystals of zirconium. Oxide of zirconium is at present attracting some attention with regard to its magnificent incandescent properties when used in the Welsbach lamp, and it is not improbable that its preparation may before long develope into an industry of some importance. Among the metals exhibited we note two tubes containing potassium and sodium melted in presence of hydrogen, thus preserving their true metallic lustre. There are also to be seen the newly-described cubes of chloride of lime mixed with gypsum, which render it possible to obtain an easily regulated current of pure chlorine gas. Salts of cerium, yttrium, erbium, as well as the metals indium and gallium in spectroscopic purity, are also shown. These last two metals would in all probability never have been discovered except for the spectroscope, as they occur in such minute proportions: the zinc ore near Freiberg, in which indium was discovered, contains only 0·1 per cent of that metal, while gallium, which may be called one of the rarest metals, is found in "black jack" in no larger quantity than 0·001 per cent. Its production in quantity is therefore a matter of extreme delicacy, requiring great care, but it has been successfully carried out by a new method discovered in Dr. Schuchardt's laboratory. Gallium is here shown in both solid and liquid forms, and it is the first time that crystals of this metal have been publicly exhibited. Another interesting body is osmic acid, shown in the form of brilliant fern-like crystals; it has long been used in physiological studies as a means of distinguishing between nerves and veins. The second section, consisting of organic compounds, contains all the most recently discovered and interesting bodies in this branch of chemical science. We first mention "Thiophen," a new organic sulphur compound, which is now being manufactured in considerable quantity by this firm: formerly obtained in the distillation of coal-tar, it is now produced from succinate of sodium and phosphide of sulphur. Following the Catalogue, attention will be drawn to the compounds of croconic acid; there are also its intermediate products, such as diacetyl-hydrochinon, &c. Of greater interest may be naphthyl-phenyl-ketondibromide, which is of great service to mineralogists in optical work, on account of its great refractive power; a similar value is attached to the heavy iodide of methylen, used for determining the specific gravity of precious stones, &c. Of the numerous alkaloids exhibited "Wrightin" takes the first place; it is the only alkaloid free from oxygen; it is found in plants, and when in a state of great purity, as in the present instance, it takes the form of long white needles. Other alkaloids here exhibited are hydrastin, from *Hydrastic Canadensis*, possessed of great crystallising powers; scapolin, from *Scapolia saponica*, which is of an extremely poisonous nature, even when diluted to 1 in 5000; and many more. Among other interesting specimens we find a collection of vegetable dyes, chlorophyll, chlorophyllan, phyllopurpurin, orcein, and the interesting group of nitrogen compounds. We cannot conclude without mentioning two new test-papers invented by Charles Wurster: one, saturated with dimethyl-para-phenylendiamin, enables us to detect the presence and quantity of wood fibre in any

paper; whilst the other, saturated with tetra-methyl-para-phenylendiamin, will detect the smallest quantity of active oxygen. The property of the latter paper is of great importance, as by its means the hygienic value of the air at any place can be readily ascertained.

Titration of Phosphoric Acid with Uranium Nitrate.—C. Mallot.—Uranium oxide forms a green lake with the colouring-matter of cochineal. This property may be utilised for giving the determination of phosphoric acid by uranium nitrate increased accuracy and precision. The preliminary operations are supposed to be conducted according to Joulie's citro-uranic method, *i.e.*, solution of the phosphate in hydrochloric acid, precipitation of the phosphoric acid by means of the citro-magnesian solution, and solution of the double ammonium-magnesium phosphate in dilute nitric acid. At this point the author adds to the nitric liquid a few drops of infusion of cochineal (obtained by treating the cochineal with boiling water) and then, with a pipette, ammonia slightly diluted until a violet colour is obtained. This is made to disappear again by acidulating slightly with nitric acid. The liquid is then heated to 100°, 5 c.c., of the acid solution of sodium acetate are added, and the standard solution of uranium nitrate is then dropped in with a burette. Each drop of the uranium nitrate produces a greenish blue spot, which becomes gradually stronger as the end of the precipitation is approached, and which disappears on stirring as long as this precipitation is not complete, leaving the rose colour of the cochineal. At the exact moment when the precipitation is complete the liquid takes a bluish green colour, which undergoes no further change on the addition of a further quantity of uranium nitrate.—*Moniteur Scientifique*, April, 1887.

AMERICAN EXHIBITION, MINERALS.

PROF. A. E. FOOTE, of PHILADELPHIA, has, in a pavilion covered with mica and in cases adjoining, near the West Brompton Entrance, 12 tons of the finest American minerals ever seen in Europe. He has selected from his stock of over 100 tons (the largest in the world) red and yellow Wulfenite, Malachite beautifully banded with Azurite, and taking a fine polish, also crystallised, Vanadinite, Brookite, Geniculated Rutile, Amazon Stone, Variscite, Turquoise, Twin Zircon, Perofskite, Hydrotitanite, Zonochlorite, Chlorastrolite, Opals, Rhodonite, Franklinite, Sphene, Samarskite, Gummite, Japanese Stibnite, Apatite, Titanite, &c., &c.

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CORNISH MINERALS.—In a trip of about two weeks through Cornwall we recently purchased several thousand specimens, including some old collections and some recent discoveries. Among them were Cronstedtite (said by COLLINS to be rare), Ludlamite, Torbernite, Chalcophyllite, Redruthite, Scorodite, Olivenite, Liebethenite, Lirocnite, Cassiterite, Clinoclase, Cbalybite in fine Crystals, Cuprite, Bornite Crystals, Enysite, Liebethenite, Henwoodite, Langite, Tenantite, Pharmacosiderite, and many other well-crystallised Minerals in Specimens from 6*d.* up. These are all on private view.

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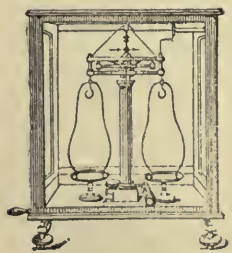

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THE CHEMICAL NEWS.

VOL. LVI. No. 1447.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 66).

THE residues from the *ether extracts* (1) and (2) of the bark and of the wood of the root contained resins which were identified as the same compound. They correspond in colour, melting-point, specific gravity, solubilities, and reactions. The resin is a transparent, ruby-coloured substance, crystalline in structure, and of a softer consistency than ordinary resin. It was examined by Hirschsohn's scheme.† It differed from all described resins in its reactions with the reagents used to identify them. It is proposed to name it yuccal.‡

The experiments with spirit of different strengths are only of value, so far as they were carried out, in showing the possibility of separating the resin into distinct parts.*

Tannin was not present in these *ethereal extracts*.

Ethereal extract (3) was green-coloured and fluorescent from the chlorophyll of the leaves. On evaporating, the *ethereal residue* was amorphous and of a green colour. The aqueous extract obtained from treating this *ethereal residue* was neutral in reaction and bitter to the taste. It contained neither gallic acid, tannin, nor glucosides. It was agitated with acetic ether, and the solvent removed a solid, which under the microscope proved to be white needle-shaped crystals arranged in bundles. Potash solution formed a yellow-coloured mixture with the crystals, hydrochloric acid discharged the colour. The subject has been too little studied to state definitely if these crystals are or are not identical with the crystals found in the *ethereal extracts* (1) and (2). But it should be noted, that unless the crystals from *ethereal extract* (3) are brought into aqueous solution mechanically by some compound not present in *ethereal extracts* (1), and (2), the indications are in favour of the crystals from (3) not being identical with them; for the crystals from (1) and (2) were insoluble in water and not removed by acetic ether.

The *ethereal residue* was treated with acidulated water and tested negatively for alkaloids.

Summary II. *Ethereal Extracts.*

	Solids extracted.	Character of residue.	Reaction with litmus.	Melting point.	Specific gravity.	Substances soluble in ether and water.	Substances soluble in alcohol and water.	Substance soluble only in ether.
1. The bark of the root ..	3·16%	Resin.	Acid.	70° C.	1·091	traces	traces	—
2. ,, wood ,, ..	1·70	,,	Slightly acid.	70° C.	1·091	,,	,,	—
3. ,, green leaf	1·25	,, Chlorophyll.	,, ,,	80° C.	—	0·34%	0·15%	0·65%
4. ,, yellow base of leaf ..	1·70	Resin.	,, ,,	79° C.	—	0·80	0·40	0·50

Yuccal is imperfectly soluble in 95 per cent alcohol; soluble in boiling absolute alcohol, in cold ether, and amyl alcohol; not appreciably soluble in chloroform, benzol, carbon disulphide, and alcoholic ammonia. Cold acetic ether dissolved the colouring matter from the resin, leaving a colourless solid. Hot acetic ether dissolved it perfectly. Yuccal when heated on platinum foil gave off as it burned a pleasant and aromatic odour. Tests failed to show the presence of benzoic or cinnamic acids. A blood-red colour reaction was obtained by warming yuccal with a crystal of ammonium molybdate and a few drops of strong nitric acid. Warm dilute nitric acid dissolved the resin, colourless; cold nitric acid gave a brownish green colour reaction. Yuccal was mixed with concentrated nitric acid and heated. After some time had passed, an energetic reaction occurred and nitrous fumes were given given off. A yellowish brown residue was one of the products of the reaction. This residue was almost insoluble in water or acids. It was soluble in alcohol and potassium hydrate.§

As the *ether extracts* (1) and (2) were concentrated, white needle-shaped crystals appeared floating in the liquids, whose physical structure, and insolubility in water and acetic ether, suggested identical substances. The crystals separated from yuccal by the lead acetate method, already described, have not been sufficiently studied to identify them with the white needle-shaped crystals in the *ether extracts* nor with any class of chemical compounds. However, the absence of gallic acid, glucosides, and alkaloids in the aqueous extracts from the *ethereal residues*, would show that the crystals separated from yuccal are a constituent part of the resin.

The *ethereal residue* insoluble in water was a mixture of two resins (I.) and (II.). The one (I.) was dissolved by absolute alcohol, the other (II.) was mostly soluble in ether. The alcoholic residue was crystalline. It was insoluble in acetic ether, but was saponified with alcoholic soda. The ether residue was a resin anhydride; it was insoluble in alcohol and in alcoholic or aqueous alkalies.

The amorphous and green-coloured *ethereal residue* was not entirely re-dissolved by cold ether. It was soluble in chloroform, benzol, and carbon disulphide; incompletely soluble in cold alcohol, and insoluble in amyl alcohol. It was slightly soluble in 95 per cent alcohol and in acetic ether. The latter separated the green colouring matter from it. The resinous mass insoluble in acetic ether melted at 80° C. It was not saponified. This resinous mass insoluble in acetic ether is a mixture of the two resins just described (I.) and (II.). It was noticeable that the resinous mass was not saponified. Resin (I.) was saponified. Resin (II.) did not saponify, and as this resin exceeded in amount by 0·5 per cent resin (I.), it would show that a certain percentage of resin anhydride in a mixture of two resins forbids the saponification of the mixture.

It was not determined if the crystals dissolved by water and separated by acetic ether were a part of resin (I.) or resin (II.) or an independent compound.

Ethereal extract (4) was a turbid yellow liquid. On evaporating, a reddish yellow granular solid remained. The extract from the aqueous treatment was tested with negative results for tannin, gallic acid, glucosides, and alkaloids. The *ethereal residue* insoluble in water was identified as a resin. It was soluble in ether, benzol, chloroform, and acetic ether; incompletely soluble in cold

* Reprinted from the *Transactions of the American Philosophical Society.*

† *Loc. cit.*

‡ See foot-note, *ether extract* (2).

§ See foot-note 3, *ether extract* (2).

* The amount of material on which these experiments, as well as others described in this paper, were tried, was too small in quantity for me to obtain more conclusive results. The facts which have been acertained will serve as a guide in future investigations.

absolute alcohol, amyl alcohol, carbon disulphide, and oil of turpentine. It was saponified. A resin was extracted by boiling absolute alcohol from the residual powder of the leaves (the yellow base) which was identified as the same resin, and the name of pyrophæal* was proposed for it.

I. Resins (1) and (2) are identical substances (yuccal).

II. *Ethereal residue* (3) is a mixture of two resins, and a crystalline principle soluble in water.

III. Resin (4), pyrophæal, is identical with a resin found in *alcoholic extract* (4).

(To be continued).

ON A SHARP LINE SPECTRUM OF PHOSPHORESCENT ALUMINA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

(Continued from p. 62).

IN the article published in last week's CHEMICAL NEWS I was only able to illustrate two spectra with cuts borrowed from my previous papers, there being no time to get new spectra engraved. I now fulfil the promise I then made of publishing drawings of the different spectra carefully mapped to scale; at the same time I have had Fig. 1 recut larger, so as to make it comparable with the others. All the spectra are drawn to the $1/\lambda^2$ scale.

Fig. 1 is the spectrum shown by purified alumina before it has undergone many fractionations. This is the same spectrum which I described and illustrated in a paper "On the Crimson Line of Phosphorescent Alumina," sent to the Royal Society December 30th, 1886.

Fig. 2 is a drawing of the most prominent lines in the sharp line spectrum of phosphorescent alumina, as described on p. 60. It was obtained by precipitating alumina by ammonia from the *high* end of the fractionations of pure ammonia alum after more than one hundred crystallisations. The precipitated aluminium hydrate was dried and calcined at a bright white heat.

Fig. 3 is the sharp line spectrum given by phosphorescent alumina obtained by calcining sulphate of alumina from the high end of the fractionation of ammonia alum. As this particular sample of alumina gives a spectrum which is well known to me, I keep it as a standard to try the effects of other earths upon it. Fig. 3 only differs from Fig. 2 in containing some very faint lines omitted from the latter spectrum.

The following Table gives approximate measurements of the spectrum shown in Fig. 3:—

Scale of spectroscope.	λ.	$1/\lambda^2$
10·55	6940	20765
10·48	6773	2180
10·41	6617	2284
10·39	6575	2313
10·36	6514	2357
10·03	6395	2445
10·22	6248	2562
10·20	6214	2590
10·19	6917	2604
10·14	6111	2678
10·13	6095	2692
10·04	5955	2820
10·02	5924	28495
10·01	5909	2864
9·96	5838	2934
9·94	5810	2962
9·92	5782	2991
9·90	5754	3020
9·88	5729	3047
9·81	5639	3145
9·74	5554	3242
9·66	5462	3352
9·63	5430	3392
9·555	5350	3494
9·37	5170	3742
9·07	4922	4128

There are other lines corresponding to those in the samarium-aluminium spectrum, but they are too faint to measure with accuracy.

Fig. 4 is the fine line spectrum given, after ignition to bright whiteness, by the same mixture of alumina with 2 per cent of samaria which yielded Spectrum No. 5 after being only heated to redness. M. de Boisbaudran considers that this spectrum belongs to samarium and corresponds with the one shown in Fig. 5. A comparison of Fig. 4 with Figs. 3 and 5 will, however, show that whilst there is no connection between Figs. 4 and 5, there is the closest resemblance, short of actual identity, between the spectra in Figs. 4 and 3; this proves therefore, that the new sharp line spectrum is caused by alumina, and not by samaria or either of its constituents, Gε and Gγ, or Sδ.

In the following Table are given approximate measurements of the lines shown in the spectrum, Fig 4:—

Scale of spectroscope.	λ.	$1/\lambda^2$
10·49	6795	2166
10·47	6757	2195
10·41	6617	2284
10·39	6575	2313
10·36	6514	2357
10·30	6395	2445
10·22	6248	2562
12·20	6214	2590
10·19	6917	2604
10·14	6111	2678
10·13	6095	2692
10·08	6015	2764
10·06	5985	2792
10·02	5924	28495
10·01	5909	2864
9·96	5838	2934
9·94	5810	2962
9·92	5781	2991
9·88	5729	3047
9·85	5689	30895
9·81	5639	3145
9·74	5554	3242
9·71	5519	3283
9·66	5462	3352
9·63	5430	3392
9·62	5418	3406
9·57	5365	3474
9·54	5335	3514
9·37	5170	3742
9·07	4922	4128

The slight differences between the spectra yielded by alumina (Fig. 3) and by a mixture of alumina and samaria (Fig. 4) are that the well known crimson line, 1 λ^2 20765, which can be seen faintly in the alumina, is not visible in the alumina and samaria mixture, that several of the lines seen faintly in the one are strong in the other, and that there is a slight difference at $1/\lambda^2$ 2820,—where in alumina there is a rather sharp but faint line instead of the two very faint and nebulous bands, at $1/\lambda^2$ 2764 and $1/\lambda^2$ 2792, seen with alumina-samaria. On the whole, except in the case of the crimson line, $1/\lambda^2$ 20765, the chief effect of the 2 per cent of samaria has been to brighten up most of the alumina lines, especially in the red and orange parts of the spectrum.

Fig. 5 is last week's Fig. 2, repeated here for purpose of comparison; it is the figure with which I illustrated

* Pyrophæal. *Science*, September 11, 1885.

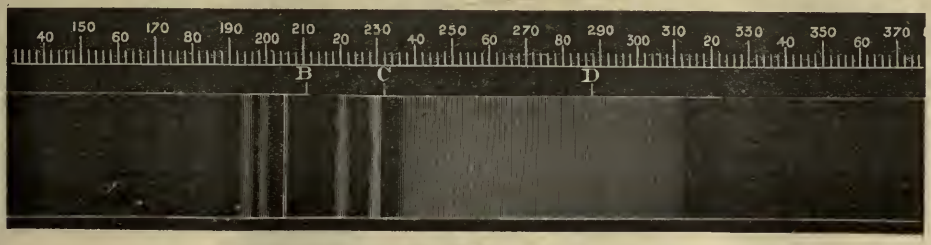

FIG. 1. Alumina, unfractionated. Band spectrum.

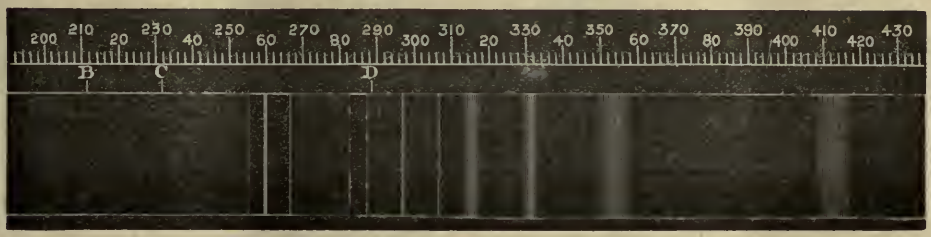

FIG. 2. Alumina, fractionated. Sharp line spectrum.

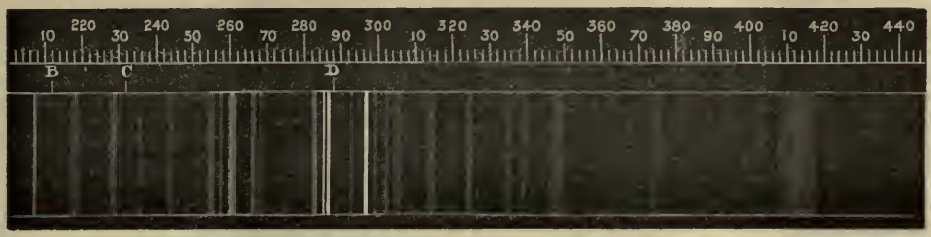

FIG. 3. Alumina, fractionated. Sharp line spectrum.

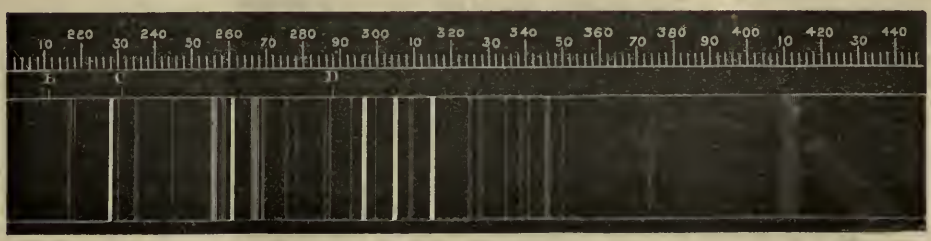

FIG. 4. Alumina-Samaria. Sharp line spectrum.

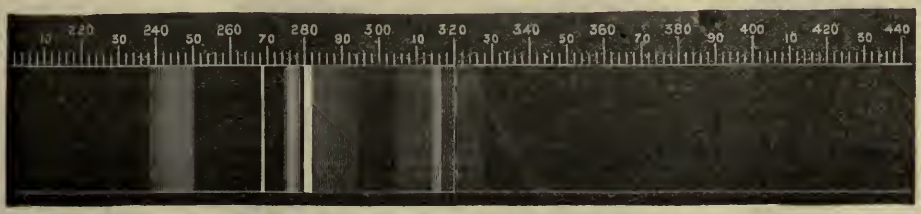

FIG. 5. Alumina-Samaria. Band spectrum.

the Samarium-Aluminium spectrum in my paper of June 18th, 1885. It is the same spectrum that is described by M. de Boisbaudran in last week's *Comptes Rendus* as being yielded by a mixture of 2 per cent samaria with alumina heated to full redness, and it is practically the same as that which I have produced by mixing 2 per cent of samaria with some of the alumina of Fig. 3 and igniting to redness.

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

In connection with an inquiry into the equivalent and the atomic weight of thorium, we examined the other rare earths occurring along with thoria in the thorites of Brevig and Arendal. Their nitrates yielded very fine absorption-spectra, displaying several lines peculiar to the compounds of didymium, samarium. erbium, and thulium, as well as to Soret's earth X, and to the holmium compounds.

An accurate measurement of the absorption-spectra of the thorite earths led to the important observation that in this case only a portion of certain absorption-bands peculiar to the rare earths was visible. Thus, of all the lines of Soret's X or of holmium visible in the spectrum of Brevig thorite, only one line was visible with great intensity. It was the band which, according to various authors, is ordinarily given as the sixth faintest band, and plays, therefore, only a subordinate part in the ordinary spectrum of holmium. The more intense lines Xα, Xβ, Xγ, Xδ, &c., were either quite invisible in the spectrum of Brevig thorite, or only very faintly visible. Hence the conclusion was drawn that Soret's X or holmium is no simple body, but consists of at least two constituents, one of which occurs almost free from the other among the rare earths of the Brevig thorite. The nitrate of this earth has, in its absorption-spectrum, only one band at $\lambda = 428{\cdot}7$.

This observation led to a further investigation of the spectra of the rare earths. Besides the earths of the thorites of Brevig and Arendal, there were examined those obtained from Wœhlerite, from the Fergusonites of Ytterby and Arendal, and from the euxenites of Hitterö and Arendal. At the authors' disposal there was also abundant didymium material from the cerite of Bastnäs, and they were finally indebted to Prof. Cleve for some preparations from his last researches on didymium and samarium.

The result of these investigations was that most of the so-called rare elements whose compounds give absorption-spectra are complex bodies. As a preliminary the authors mention briefly the conditions under which the measurements of the absorption-spectra were undertaken.

For the observations they used the universal spectroscope described in *Berichte*, xix., p. 2739, and they employed generally the simple 60° prism of a dispersion $A - H_2 = 4° 18'$ in preference to the use of several prisms, as it was thus possible to observe in a better illuminated spectrum, and the presence of very faint absorption-bands was thus less liable to be overlooked. Besides, in a spectrum of small dispersion all the bands appear more sharply defined than in one produced by a larger system of prisms.

The determinations of locality in the spectrum were effected by means of the cross marked upon the glass plate in the slide of the eye-piece. It can, on the one hand, be moved alone by a micrometer screw provided with a measuring-drum and finger for entire revolutions, and on the other it can be moved along with the observing telescope by a micrometer movement by means of a large measuring-drum for entire rotations.

The values for the wave-lengths of the lines as given in the authors' tables were obtained by means of the latter arrangement. The measurements were carried out on the principle that not the breadth and the position of an absorption-band at any degree of concentration of the solution is very characteristic of a compound, but only the position of the maximum of darkness in such band. The middle of the cross was therefore adjusted to the darkest region of the absorption-bands. If this was impracticable in a band on account of too great absorption, the liquid under examination was diluted until the band had only a small breadth, and its maximum of darkness could then be accurately determined.

As for the intensities of the absorption-bands given, they are only relative statements of the degree of absorption of one and the same solution, the solution of a certain fraction. No attempt was made to bring all the solutions to the same degree of concentration, as it appeared superfluous for the object in view. It seemed merely necessary to determine the relative intensities of the bands always in one solution. The intensities have not been indicated by numbers, *e.g.* from 1 to 10, since a word or two seemed better to express the phenomena observed.

As for the conversion of the values read off on the telescope drum into wave-lengths, the authors once for all standardised their apparatus at a temperature of 17° by observing a great number of Frauenhofer lines and other fixed lines, and carried on the measurements of absorption-spectra at the same temperature.

1. *Thorite of Brevig.*

As mentioned in a former memoir on the equivalent and atomic weight of thorium, the thorite of Brevig contains, in addition to thoria, considerable quantities of other rare earths. After the latter had been separated from the thoria by the process formerly described, the anhydrous sulphate of the mixed earths was dissolved in ice-water, precipitated with oxalic acid, whereby considerable quantities of iron, manganese, and uranium remained in solution, and the oxalates were ignited. The residual brownish-yellow earth was completely converted into sulphate by repeated treatment with water and sulphuric acid. The sulphate was dissolved in 3 to 4 parts of ice-cold water. From this solution the hydrates of the earths were thrown down with ammonia and washed by decantation. They then dissolved readily in nitric acid, yielding a flesh-coloured liquid, which was evaporated down and the residual nitrates of the rare earths were heated for some time more strongly, whilst nitrous vapours escaped. The thorium and cerium nitrates still present were decomposed, and remained as insoluble basic compounds on treatment with water. The filtrate contained the didymium and yttrium earths present in the mineral, and gave the following absorption spectrum.

In Table I. and in all following tables the values given under the head "wave-lengths formerly observed" are those which have been found for the absorption-lines of Lecoq de Boisbaudran, for the element X or holmium as mean results from the measurements of Soret and Lecoq de Boisbaudran. The earlier measurements are by R. Thalen, and those values which are for the present marked as Di have been observed by the authors themselves in didymium materials of different origins. Although it has been shown by the researches of Auer von Welsbach that didymium is composed of two bodies, neodymium (Nd) and praseodymium (Pr), the symbols Nd and Pr have not been introduced into the present investigation, since it appeared that these bodies are still compounds. The symbol Di has been still retained for the total body formerly known as didymium; on the more precise designation of its components see below. The same holds good with holmium, thulium, &c. The didymium lines have not even been accurately measured by the authors, since notwithstanding various accounts concerning them, no accurate and especially no complete

determinations seem to exist. Auerbach's researches, the result of which rests on spectroscopic observations, contain no precise measurements of the didymium spectrum, but merely drawings which allow only of an approximate comparison.

As for the occurrence of the rare earths in the thorite of Brevig, it appears from Table I. that there are present in this mineral, in addition to thorium, erbium, Soret's X, thulium, samarium, and didymium. Further, in the absorption-spectrum of the nitrates there was observed a

(I.) *Thorite of Brevig.*

Observed position of maximum darkness. Position of Telescope-drum.	Wave-length observed.	Wave-lengths formerly observed.	For.	Intensities of bands.
2354	728·3	728·3	Di	Rather strong.
2381	708·2	708·2	Di	Very faint.
2411	686·0	684·0	Tm	Extremely faint.
2420	679·3	679·4	Di	Faint.
2457	654·1	654·7	Er	Faint.
2480	640·6	640·4	X	Very faint.
2505	626·1	626·1	Di	Faint.
2568	591·5	591·5	Di	Faint. } Lie on a fainter absorption-ground,
2596	579·2	579·2	Di	Faint. } extending from λ = 593 to λ =
2605	575·4	575·4	Di	Faint. } 574.
2689	539·6	—	(?)	Very faint.
2713	531·3	531·3	Di	Faint.
2721	529·2	530·0	Di	Extremely faint.
2740	523·6	523·1	Er	Strong.
2747	521·6	521·5	Di	Very faint.
2781	512·2	512·2	Di	Faint, broad.
2872	485·9	485·5	X	Very faint.
2888	482·3	482·0	Di	Very faint, but sharp.
2913	476·5	477·7	Sm	Faint.
2944	469·2	469·0	Di	Stronger.
2974	462·3	463·2	Sm	Faint.
3068	445·6	445·1	Di	Very strong.
3076	444·2	444·7	Di	Very strong.
3164	428·7	428·5	X	Strong.
3240	417·3	416·7	Sm	Strong.

(II.) *a. Thorite of Arendal; Nitrates of the Yttria-Earths.*

2413	684·4	684·0	Tm	Rather strong.
2455	654·7	654·7	Er	Stronger than foregoing.
2592	580·9	579·2	Di	Extremely faint.
2682	542·6	542 6	X	Faint.
2698	535·6	536·3	X	Rather strong.
2721	529·2	530·0	Di	Very faint.
2740	523·6	523·1	Er	Strong; stronger than λ = 654·7.
2747	521·6	521·5	Di	Faint.
2864	488·8	—	(?)	Faint; does not coincide with X line λ=485·5.
2920	474·9	474·5	X	Extremely faint.
2943	469·4	469·0	Di	Very faint; at the spot where thulium β=λ465·3 lies there was no line, though Tm α = 684·0 was fairly strong.
3028	452·6	453—449	X	Strong.
3076	444·2	444·7	Di	Faint.
3163	428·9	428·5	X	Scarcely visible.
3240	417·3	416·7	Sm	Rather strong.

b. Thorite from Arendal; Nitrates of the Earths precipitated by Sulphuric Acid.

2353	729·0	728·3	Di	Very strong.
2382	707·5	708·2	Di	Very faint.
2419	680·0	679·4	Di	Faint.
2568	591·5	591·5	Di	Extremely faint.
2595	579·6	579·2	Di	Very strong.
2604	575·8	575·4	Di	Very strong.
2712	531·6	531·3	Di	Extremely faint.
2740	523·6	523·1	Er	Faint.
2747	521·6	521·5	Di	Strong.
2772	514·6	514·6	Di	Faint.
2780	512·5	512·2	Di	Faint.
2887	482·5	482·0	Di	Strong.
2920	474·9	474·5	X	Faint.
2943	469·4	469·0	Di	Strong.
2974	462·3	463·2	Sm	Extremely faint.
3068	445 6	445·1	Di	Strong.
3076	444·2	444·7	Di	Strong.
3163	428·9	428·5	X	Very faint.

(III.) *Wœhlerite from Brevig.*

Observed position of maximum darkness. Position of Telescope-drum.	Wave-length observed.	Wave-lengths formerly observed.	For.	Intensities of bands.
2354	728·3	728·3	Di	Strong.
2420	679·3	679·4	Di	Faint; the thulium line λ = 86·4 not visible.
2455	654·7	654 7	Er	Rather strong.
2505	626·1	626·1	Di	Very faint.
2568	591·5	591·5	Di	Faint
2596	579·2	579·2	Di	Strong.
2604	575·8	575·4	Di	Strong; λ = 579·2>575·4.
2688	539 9	—	(?)	Faint, sharply defined; observed also in the spectrum of the thorite of Brevig.
2698	535·6	536·3	X	Faint.
2741	523·3	523 1	Er	Strong.
2747	521·6	521·5	Di	Strong.
2773	514·3	514 6	Di	Faint.
2782	511·9	512·2	Di	Very faint.
2864	488 8	—	(?)	Does not coincide with the X line λ = 485·5 which was not perceptible in the wœhlerite material.
2887	482·5	482·0	Di	Rather strong.
2911	477·0	477·7	Sm	Faint.
2944	469·2	469·0	Di	Strong.
2975	462·1	462·3	Sm	Extremely faint.
3030	452·3	453—449	X	Extremely faint.
3068	445·6	445 1	Di	Strong.
3076	444·2	444·7	Di	Very strong.
3164	428·7	428·5	X	Faint; equal X λ = 536·3
3240	417·3	416·7	Sm	Very faint.

(IV.) *Cerite from Bastnäs: Didymium and Samarium Material.*

2353	729·0	728·3	Di	Strong.
2405	690·5	—	(?)	Very faint.
2420	679·3	679·4	Di	Rather strong.
2480	640·6	640·4	X	Scarcely perceptible.
2505	626 1	626·1	Di	Faint; resolvable into two fine lines at λ = 23·4 and λ = 618·8
2595	579·6	579 2	Di	Very strong.
2604	575 8	575·4	Di	Very strong.
2712	531·6	531·3	Di	Faint.
2735	525 2	—	(?)	Faint.
2747	521·6	521·5	Di	Very strong.
2772	514·6	514·6	Di	Faint.
2780	512·5	512 2	Di	Faint.
2887	482·5	482·0	Di	Strong.
2911	477·0	477·7	Sm	Faint.
2943	469·4	469 0	Di	Stronger than λ = 482 0.
2970	463·2	463 2	Sm	Very faint.
3071	444·2	444·7	Di	Very strong.
3135	434·0	—	(?)	Very faint.
3163	428·9	428·5	X	Faint.
3240	417·3	416·7	Sm	Faint.

faint but distinct line at λ = 539·6, which cannot be identified with any line hitherto observed in the spectra of the rare earths.

2. *Thorite from Arendal.*

On the occurrence of other rare earths in Arendal thorite along with thoria, and on the separation of these earths, one of the authors has formerly reported (*Berichte*, xv., p. 2524). The sulphuric solution of the mixed earths finally obtained was completely saturated with potassium sulphate, and thus the yttria earths were separated from the earths precipitable by potassium sulphate. Both were again converted into nitrates, and gave solutions for which were found the absorption-spectra (II.).

The thorite from Arendal, like that of Brevig, contains, therefore, nearly all the rare earths whose compounds produce absorption-spectra; further, at λ = 488·8, there was observed a line hitherto unknown. Hence it appears that in the thorite of Arendal, as in that of Brevig, there exists a rare earth not yet recognised. As regards the method of separating didymium from the yttria earths by saturating the solution with potassium sulphate, the tables (II.) show that in this manner only an imperfect separation is effected. The solution of the sulphates of the mixed earths was saturated with potassium sulphate for some days until no more double sulphates were precipitated. Yet, in the spectrum of the yttria earths, several didymium lines—certainly faint—were observed, and, on the other hand, in the spectrum of the earths precipitated by potassium sulphate there were found one erbium and two X lines.

3. *Wœhlerite from Brevig.*

In Wœhlerite neither yttria earths nor cerium metals had been hitherto discovered, though this mineral has been analysed by Scheerer and Rammelsberg. The analyses of both these chemists sum up only to 98·9 per cent, and are therefore not quite complete. On working up one kilo. of Wœhlerite the authors found about one per cent of rare earths. The pulverised mineral was dis-

solved in hydrochloric acid, and from the solution previously freed from silica and niobic acid the greater part of the zirconia was precipitated as oxychloride by an excess of hydrochloric acid. The filtrate was then mixed with an excess of oxalic acid, by which all the yttria and cerite earths and some niobium and zirconium remaining in solution were precipitated. The mixed oxalates were ignited, the oxides dissolved in nitric acid, the nitrates formed were partially decomposed by heat and treated with water, when the niobium and zirconium compounds remained insoluble, and a solution was obtained containing only the stronger rare bases of Wœhlerite, which served for the spectroscopic investigation (III.).

In Wœhlerite there occurs, besides the elements given in the analyses of Scheerer and Rammelsberg, and the rare earths above named, uranium, since, in the spectrum of Wœnlerite the lines Ur_α, Ur_β, Ur_γ, and Ur_δ have been distinctly observed.

4. *Cerite from Bastnäs.*

A material of rare earths obtained from the cerite from Bastnäs, and which contained didymium in the old acceptation of the word, gave the spectrum (IV.) in the solution of its nitrates.

b. Perfectly identical with the above spectrum is that of a didymium material due to the kindness of Prof. Cleve. It must be noticed that in the material from Bastnäs, as well as in that supplied by Prof. Cleve, there were three faint lines $\lambda = 690{\cdot}5$, $525{\cdot}2$, and $434{\cdot}0$, which could not be identified with any absorption lines hitherto known. The interpretation that these lines had escaped notice because the solutions used were not sufficiently concentrated or were observed in too shallow a layer is not admissible, since, in the tables contained in this memoir, the authors had the opportunity of observing spectra in which other didymium lines, generally faint, were strongly visible, but the three lines did not appear. There is, therefore, in the didymium material from the cerite of Bastnäs and in Cleve's material, besides Sm, X, and didymium in the ordinary meaning, a small quantity of another element.

(To be continued).

IDENTITY OF THE PHOTOSALTS OF SILVER WITH THE MATERIAL OF THE LATENT PHOTOGRAPHIC IMAGE.

By M. CAREY LEA, Philadelphia.

In the first part of this paper I described certain strongly coloured forms of silver chloride, bromide, and iodide, obtained independently of any action of light, for which I proposed the name of photosalts, by reason of their identity with the products of the action of light on the normal silver haloids, both with the substance of the latent image itself and also with the principal results of the continued action of light on these haloids. It remains to prove this identity.

First as to identity with the product of the continued action of light.

If we expose silver chloride precipitated with excess of HCl to light, we get a deep purple-black substance which boiled with dilute nitric acid gives up a little silver, at the same time somewhat lightening in colour, and forming a dull purple material which closely resembles some of the forms of photochloride described in the first part of this paper,—most those produced by the action of sodic hypochlorite or of ferric chloride on metallic silver: it shows the same reactions with ammonia that they do. The brighter coloured photochlorides are not formed by the action of light on silver chloride.

But these brighter coloured chlorides can also be shown to be formed through the action of light. Most salts of silver darken by exposure, and when these dark products are treated first with HCl, and then, after thorough washing, are boiled with dilute nitric acid, we can obtain results perhaps as varied as those which I described in the former part of this paper as arising from purely chemical action.

Silver oxalate exposed for two days to sunshine, covered with water, and with frequent agitation, changed to a deep brownish black, which by treatment with HCl became a little lighter. When this product was washed and boiled with strong nitric acid it acquired a fine deep copper-red colour, the acid taking up silver. This red substance dissolved in ammonia readily, leaving a small amount of black residue; the same with sodium hyposulphite.

(This examination, made a year ago, has recently been repeated, with a view to obtaining a quantitative determination of the proportion of Ag_2Cl contained in the red product. The exposure was for about a day; the oxalate at the end of the exposure seemed absolutely black. After treatment with HCl it assumed a purple-black shade. After thorough washing and boiling with dilute nitric acid, which removed a large quantity of silver, perhaps 12 or 15 per cent of the entire quantity, it had a fine lilac-purple colour. Analysis showed that it contained about one-half of 1 per cent of subchloride, or, more exactly, 0·45 per cent Ag_2Cl was found).

The red chloride thus obtained from silver oxalate not only closely resembles the red chloride obtained by means exclusively chemical, but shows the same behaviour to reagents.

Treated with ammonia it dissolves, leaving a black residue. The formation of this residue takes place precisely in the same manner with both substances. As fast as the material dissolves the liquid becomes clouded, and an extremely fine black substance seems to form within it, which gradually falls to the bottom.

Treated with solutions of the alkaline haloids, the red chloride derived from exposed silver oxalate remains unchanged after twenty-four hours' contact with potassic chloride, and becomes paler and more lilac under potassic bromide; under potassic iodide it becomes grey. These reactions correspond with those of the photochloride.

Silver phosphate belongs to the more sensitive silver salts, and easily darkens in sunlight. In a few hours it becomes greenish all through, after which further exposure produces little visible effect. This product becomes with HCl quickly grey, and by treatment with nitric acid, after washing, light pink.

Silver tartrate by exposure to sun became quite black. With HCl this changed to reddish grey or dull pink. This product, well washed, and let stand with cold nitric acid 1·36, became first lavender and then light pink.

Silver carbonate by prolonged exposure became greenish black, and with the above treatment yielded a dull pink photochloride.

Silver pyrophosphate, even by several days' exposure to winter sun, did not blacken, but assumed an ochreous or buff shade. With HCl this passed to a sort of salmon-pink, and by heating a few minutes with dilute nitric acid to a beautiful copper shade.

Silver acetate was singularly little affected by sunlight; it looked blackish, but on closer inspection was found to be very little altered. By the same treatment as above it yielded a pale pink photochloride.

So far as examined, all silver salts thus treated yielded pink or red photochloride.

These facts may serve to show the identity of the photochloride with the principal product of the continued action of light on silver chloride and on other salts of silver, subsequently converted into chloride. I should wish, however, to use this word identity in a somewhat limited sense. When the photochlorides are formed by different methods, without the aid of light, hardly any two forms can be considered absolutely identical: they differ in colour and in proportion of subchloride, as already often mentioned; but they also differ in other respects, especially in resistance to reagents. Some forms are far more easily destroyed by nitric acid: those obtained by the

action of sodium hypophosphite (as presently to be described) are amongst the most easily destroyed by nitric acid. There is variation, too, in the degree of their resistance to ammonia.

Very similar differences are found in the stability of the photochlorides obtained by the action af light; some are much more readily attacked by nitric acid than others. The product obtained by the action of light on silver chloride resists ammonia more strongly than that obtained by the action of HCl on exposed silver oxalate. This last is quickly attacked. Generally, I think the dark coloured forms are the most stable.

At a future time it may perhaps be possible to distinguish more exactly between these varieties.

I next pass to the consideration of the identity existing between the photosalts and the material of the latent image. Before entering, however, on that matter, it is necessary to describe a reaction leading to the formation of these photosalts, somewhat differing from the reactions already mentioned, and which has important bearing on the subject.

The remarkable action which an alkaline hypophosphite exerts on salts of copper was described many years ago by M. Wurtz. Its action on silver salts, though there is no parallelism between the two, has enabled me to find a key to some of the great difficulties of the latent image.

A dilute solution of sodium hypophosphite, if poured over a mass of chloride, bromide, or iodide of silver formed in the absence of light, produces no visible effect, but has the property of bringing those substances into the condition in which they exist in the latent image. Applied in strong solution, and with the aid of heat, it produces brown-purple photochloride, bromide, and iodide of silver. I will here briefly describe the first of these compounds in order to continue the series of photochlorides, and then pass to the consideration of the latent image.

Photochloride of Silver by Sodium Hypophosphite.

Silver chloride, freshly precipitated with excess of HCl and well washed, placed in a flask with a strong solution of sodium hypophosphite and heat applied, begins to darken before the boiling-point is reached. Actual boiling for ten or fifteen minutes gives a deep chocolate colour. This product, well washed and freed from traces of metallic silver by cautious boiling with very dilute nitric acid, has a pink, red, or brown colour, varying in intensity according to the length of the action. Sometimes a lavender shade is produced, and this is more apt to be the case when the silver chloride has been precipitated with excess of silver nitrate instead of excess of HCl.

Silver determinations of two specimens of the purified product were made, indicating the presence in one specimen of 1·77 per cent of subchloride, in the other of 3·53.

By the continued action of heat for many hours a complete reduction to metallic silver takes place.

Photochloride obtained in this way has generally a brown or dull purple colour. Boiled with nitric acid it is apt to break up in as many minutes as some other forms would require hours for decomposition, yielding white chloride, whilst the nitric acid takes up small quantities of silver.

IDENTITY OF PHOTOSALTS WITH THE MATERIAL OF THE LATENT IMAGE.

It is proposed here to show—

1st. That, in the entire absence of light, sodium hypophosphite is able to affect a sensitive film of silver haloid exactly in the same way as does light, *producing a result equivalent to a latent image formed by light*, and capable of development in the same way as an actual impression of light.

2nd. That these two effects, the impression produced by hypophosphite and that by light, comport themselves to reagents exactly the same way, and seem every way identical.

3rd. That the image produced by hypophosphite on silver chloride always gives rise to a positive development, but on silver bromide may give rise either to a direct or to a reverse image, *both of these effects corresponding exactly with those of light*. More than this, sodium hypophosphite may be made to reverse the image produced by light on silver bromide, and conversely light may be made to reverse the action of hypophosphite. So exact a correspondence in these remarkable properties can scarcely be fortuitous.

I.

A silver haloid formed in the absence of light, and subjected to the action of sodium hypophosphite, gives rise to the gradual formation of subsalt, which combines with the normal salt in the manner described in the previous part of this paper. This action of the hypophosphite closely corresponds with that of light. In its initial stages it is invisible, but can be brought out, in both cases by development.

If we form a film of chloride, bromide, or iodide of silver, and with a glass rod dipped in solution of hypophosphite make marks upon it, these marks can with the utmost ease be developed in precisely the same way as an image produced by exposure to light.

A very simple mode of operating consists in imbibing photographic paper with a solution of an alkaline haloid, drying, applying a silver solution, and then thoroughly washing, all of course with careful exclusion of active light. If the silver solution is acidulated with nitric acid, a drop to the ounce, the result is brighter, but this is not important. In any case the washing must be thorough.

Marks made on this paper can be developed with the oxalate developer with the utmost facility. If a strong solution of hypophosphite is applied cold, it may be washed off at the end of a minute, but a stronger impression is obtained by allowing it to wait half an hour before developing. Or the action may be accelerated and increased in strength by laying the freshly marked paper on a hot surface, or, better, by steaming it, before applying the developer. A convenieht mode of steaming is to lay two pieces of glass on a small water-bath kept boiling, with a space between them. Over this space the paper is rested for two or three minutes. Paper prepared with a solution of KCl, KBr, or KI, dried and floated on acidulated solution of silver nitrate and well washed, if marked with strong solution of hypophosphite and steamed for two or three minutes, will develop the marks as black as ink on a white ground. The use of heat simply gives a blacker development, but a very vigorous image may be got without.

(A similar result may be obtained by substituting for the hypophosphite a dilute solution of potash and an oxidisable organic substance. With milk sugar the action is very energetic, and heat is quite superfluous).

Both these are the initial steps of reactions which, when prolonged, result in the visible formation of the coloured photosalts. It is a matter of interest that sodium hypophosphite which produces the above-described effects has no developing power whatever.

II.

The two impressions, that formed by light and that by hypophosphite, are similarly affected by reagents.

As an example of this identity of effect produced on the two impressions, I first take the action of nitric acid.

Chloride, bromide, and iodide papers were exposed to moderate diffused light under a screen with openings for a proper time to form a latent image, the chloride and bromide for four or five seconds, the iodide for twenty or twenty-five. They were then cut into halves and one-half of each was soaked in strong nitric acid for five minutes. These halves were then washed for some hours, and were developed along with the halves not so treated. Result was, latent image on silver chloride almost if not quite uninjured; on silver bromide, somewhat affected but still strong; on silver iodide entirely destroyed.

Similar portions of the same papers were then marked with hypophosphite, and were cut into halves, and one-half was subjected to the action of nitric acid in exactly the same way as the previous. The result was exactly as before. The hypophosphite marks on the half of the chloride paper that had been treated with acid came out in development as vigorously as on the half that had not been treated. The bromide paper showed the marks weakened by the acid, but still strong; on the iodide not a trace appeared. In all respects the result was the same; what the one resisted the other resisted, what destroyed the one destroyed the other.

Another confirmation is presented by the action of the alkaline haloids upon the latent image.

The latent images produced by light on chloride, bromide, and iodide of silver were all treated with cold and moderately strong solutions of potassic chloride, bromide, and iodide for half an hour, and were then subjected to development. It was found that all three silver salts bore the action of potassic chloride and bromide fairly well; the images were somewhat weakened, but strong developments were obtained without difficulty. But when potassic iodide was applied the latent image was totally destroyed.

The visible effect of the alkaline haloids on the photosalts exactly corresponds with their action on the latent image. Potassic chloride and bromide, applied in moderately strong solution, and cold have little effect, but potassic iodide quickly destroys them.

Therefore the action as well of nitric acid as of KCl, KBr, and KI, is exactly the same on the latent image impressed by light on AgCl, AgBr, and AgI as it is on the corresponding photosalts.

III.

The impressions produced by alkaline hypophosphite upon silver chloride always give rise to direct images, darker than the ground on which they are formed. The same substance produces an impression on silver bromide which may, by development, produce either a direct or a reverse image. So that there is a perfect parallelism with the action of light.

The reverse action of light, sometimes called solarisation, shows itself as follows. A film of bromide being exposed to light, part covered by an opaque screen, the exposed portion receives an impression capable of development, and this impression grows in strength to a certain point, then recedes and reaches a condition in which it is less susceptible of development than before exposure. All bromide films, even unexposed to light, will darken in a developing solution in time. The portion that under the action of light has reached the reverse stage, resists the reducing action of the developer better than that which was not exposed at all, and consequently appears after development as light on a dark ground, and is therefore a reverse image. As to the cause of this action we are as yet wholly in the dark. If the continued effect of light was simply to restore the affected part to its original state, we might attempt an explanation by affirming that the continued action of light undid its own work. But the fact of the resistance to reduction being greater than before exposure, shows that some as yet unknown action of light is in play. The reverse action cannot be due to oxidation, as has been suggested, because hypophosphite reverses and certainly cannot oxidise.

The reversing action of light on silver bromide finds its counterpart in the action of sodium hypophosphite.

If we take bromide paper (it is immaterial whether in making it the bromide or the silver solution be applied first, but for these experiments on the reversal of the image it is essential that a pure neutral silver solution be employed, and that after the second solution has been applied the paper should be thoroughly washed, all the operations being, of course, performed by inactive light):—If we take such paper and make marks on it with a strong solution of hypophosphite, and then throw the paper into potassio-ferrous oxalate, we shall get a direct development; the marks will be stronger than the ground. If now we continually weaken the hypophosphite solution, we shall presently reach a point at which these marks are in development almost wholly indistinguishable from the ground on which they were made. But continuing the dilution still further, we presently reach a point at which the marks reappear, but this time reversely, as lighter marks on a darker ground. This result is obtained with about a two per cent solution; the first mentioned effect comes with a solution of 25 or 30 per cent. So that, according as we use the hypophosphite solution stronger or weaker, we obtain exactly opposite effects. Here the parallelism is striking but not perfect, at least it remains to be explained why the action in the two cases proceeds in a reverse order. All the other reactions show a perfect identity.

Time will also sometimes produce the same effect as dilution. Paper marked and put way for twenty-four or forty-eight hours, giving at first a direct image, may after that time give a reverse one. This effect is extremely uncertain, and, I think, exceptional. I have kept very many pieces for periods from a few hours to several weeks, which first and last gave direct images only; a few became reversed. But the experiment itself, the opposite effect of strong and weak solutions, is liable to no such uncertainty.

Again, we may make light and hypophosphite interact and each reverse the other's action.

To make hypophosphite reverse the action of light, I take a piece of silver bromide paper, expose it to the action of diffused daylight for a few seconds, then, taking it to the dark room, make marks upon it with a glass rod dipped in solution of hypophosphite. On developing with potassio-ferrous oxalate the marks appear lighter than the ground. Or what is perhaps more striking, we take two pieces of such paper, retain one in the dark room and expose the other from 5 to 20 seconds to diffused light, then make marks on both with a glass rod dipped in strong solution of hypophosphite, and then, after allowing a few minutes for the hypophosphite to act, place them both in a solution of potassio-ferrous oxalate. The marks will develop, in the one case, as dark on a light ground, in the other (that exposed to daylight) as light on a dark ground.

We have here made the hypophosphite imitate the action of light: it has reversed the image in the same way as would result from a prolonged exposure to light. It will next be shown that light may be made to imitate the action of hypophosphite, and reverse the effect already produced by that or other reducing agent.

If we take the red or purple silver bromide, preparing it with exclusion of light, and the same precaution as in the case of a dry plate, and extend it over paper (it is best, though not essential, to mix it with a little gelatin to enable it to retain its hold on the paper in the subsequent treatment), dry it, and expose it to light under a screen, such as a piece of opaque stiff pasteboard with openings cut in it; then apply potassio-ferrous oxalate, we shall obtain a very remarkable effect; all the parts exposed to light take a reversed development, and appear as lighter spaces on a dark ground. And this goes so far that we may expose till we get a visible and quite strong image, darker than the ground, and yet in development this darker portion will come out lighter than the ground. Indeed, I have one specimen which shows almost white figures on an intensely black ground. Before development these light figures were brown, by exposure to light, on a rose-purple ground. I have seen few more curious results than this.

From the foregoing it follows that red bromide, notwithstanding its intense colouration, is in the same condition respecting light as normal silver bromide that has received an impression of light so strong that any further influence of light would cause reverse action, only that a vastly larger proportion of its molecules are affected. In the case of the latent image formed by light on normal

bromide, it would seem that the particles affected, although numerous enough to serve as a basis of development, are still too few and too scattered to be visible or affect the colour. The photobromide, on the contrary, has its mass made up of them. Then, if exposed to light, the light carries them a stage farther—brings them to the reverse or "solarised" condition, and the parts affected by light develop less strongly than those not exposed.

So light can act the part of hypophosphite and hypophosphite that of light, interchangeably; each can produce a direct action, each a reverse, and each can reverse the other.

It then appears that in all the numerous ways in which it is possible to compare the photosalts with the material of the latent image they are found to be identical. The proofs based on development generally, and especially on the reversal of the latent image, seem very strong, and these receive additional support from the exact identity of reactions shown by the photosalts and by the material of the latent image.

The question of the identity of the photosalts with the products of light on the silver haloids might perhaps be left with some confidence to the cumulative proofs here offered. But I hope to be prepared to give in a future number of this journal additional evidence from a new direction.—*American Journal of Science*, June, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Academie des Sciences. Vol. cv., No. 3, July 18, 1887.

The Transmission between the Aromatic and the Fatty Series. — MM. Berthelot and Recourda. — The passage from a body of the fatty series to a body of the aromatic series by dehydration is accompanied by a considerable escape of heat, that is, by a loss of energy corresponding with the excess of stability acquired by the fundamental hydrocarbonic nucleus.

Solidification of Liquids by Pressure. — E. H. Amagat.—Theoretically, Thomsen's formula enables us to foresee that at a given temperature the solidification of a body may become possible under a sufficient pressure, on condition that its density shall be greater in the solid than in the liquid state. The previsions of this formula have been verified for several bodies by W. Thomson, Mousson, Bunsen, Hopkins, and Batelli. The author has in this manner solidified carbon disulphide at $-19{\cdot}5$ under a pressure of 210 atmospheres, at 0° under 620, at $+10^{c}$ under 900, and at $19{\cdot}5^{\circ}$ under 1160. It may be asked if there is not, for each liquid, a temperature above which solidification cannot be produced at any pressure, that is to say, a critical point of solidification.

A New Method of forming the Cyanomalonic and Benzoyl-cyanacetic Ethers.—Alb. Haller.—In former series of communications presented to the Academy the author has shown that the malonic and benzoyl-acetic sodium ethers, on treatment with cyanogen chloride, yield cyanic compounds which behave like true acids. These derivatives may also be obtained by setting out from cyanacetic sodium ether, which is treated with chlorocarbonic ether or benzoyl chloride.

Preparation of Pure Valerianic Acid.—E. Duclaux. —The author uses an excess of amylic alcohol and keeps the liquid cold. A little acetic acid is also formed, but both are easily separated from each other in dilute liquids by distillation. The valerianic acid passes over almost entirely in the first quarter of the distillate.

MISCELLANEOUS.

Imperial Russian Technical Society.—*Notice from the Organisation Committee of the Exhibition for Mineral Oils Industry and Lighting Materials.*— By His Imperial Majesty's authorisation the Imperial Russian Technical Society organises in the present year 1887 an Exhibition of lighting materials, and mineral oils. To the Exhibition are admitted all apparatus and materials serving for producing and applying every kind of artificial light, and materials referring to mineral oils industry. The programme will include:—(*a*) Historical collections of apparatus and materials serving for lighting in ancient times. (*b*) Lighting by solid and liquid materials of vegetable and animal origin. (*c*) Gas lighting materials, and apparatus for its manufacture and use. (*d*) Lighting by electricity. (*e*) Special sources of light. (*f*) Lamps for burning mineral oils. (*g*) Photometry. (*h*) Mineral oils and their derivatives. Apparatus and contrivances for procuring, preserving, transporting, and treating mineral oils. (*i*) Heating apparatus fed by mineral oils and their derivatives. (*j*) Mineral oils for lubricating. The Imperial Russian Technical Society, in organising the present Exhibition, has chiefly in view to show the present technical state of lighting, and of mineral oils production, and, in accordance with this aim, will pay special attention to a most complete collection of objects, presenting peculiar qualities, and in general being able to characterise the state of the above named branches of industry. For the most important and useful inventions, besides medals and diplomas of honourable mention, money premiums will be awarded. The Exhibition will be opened in the month of November of the present year and will last three months. The exhibits will be received from the 27th of August to the 27th of October. In bringing this to public notice, the Committee of the Exhibition invites all those who desire to participate therein to make known their claims as soon as possible, and not later than the 27th of August, with the mention of objects to be exhibited and necessary space (length, breadth, and height). For space no charge is made. Applications to be made by letter or personally from the 13th of May on Mondays, Wednesdays, and Fridays, from 12 till 2 o'clock, to the Committee of the Exhibition at the following address:—St. Petersburg, Panteleimonovskaja, No. 2; The Russian Imperial Technical Society; To the Committee of the Exhibition. The rules of the Exhibition and all the necessary information can be obtained at the same place.

Substitute for Fehling's Solution. — Schmiedeberg recommends an alkaline solution of copper in which mannite is used in place of the salt of Seignette.—*Chemiker Zeitung.*

The London Hospital and Medical College,
MILE END, E.

The SESSION 1887-88 will commence on Saturday, October 1st, 1887. The New Buildings which were opened by T.R.H. The Prince and Princess of Wales, on May 21st, afford more than double the accommodation which was provided formerly.

FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All Resident and other Hospital Appointments are free, and the holders of all the Resident Appointments are provided with rooms and board entirely free of expense. The Resident Appointments consist of five House Physiciancies, five House Surgeoncies, one Accoucheurship, and one Receiving-room Officer; Dressers and Maternity Pupils also reside in the Hospital. Special Classes for the Preliminary Scientific and Intermediate M.B. Examinations of the University of London and for the Primary and Pass Examinations for the Fellowship of the Royal College of Surgeons of England are held throughout the year. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis, and the Metropolitan, Metropolitan District, East London, and South-Eastern Railways have stations within a minute's walk of the Hospital and College.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1448.

ON THE LINE SPECTRA OF PHOSPHORESCENT YTTRIA AND LANTHANA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

(Continued from p. 62).

I give below carefully drawn maps and tables of the phosphorescent spectra of yttria and lanthana described in the Chemical News for August 12th, together with tables giving the approximate measurements of the lines shown in the drawings.

	Scale of spectroscope.	$1/\lambda^2$	λ.	
	9·860	3075	5703	Faint, sharp.
	9·830	3117	5660	Very faint, nebulous.
	9·820	3131	5651	Very faint, sharp.
γ	9·810	3145	5639	Nebulous, strong.
	9·790	3173	5614	Very faint, nebulous.
	9·770	3200	5590	,, ,,
	9·750	3228	5566	,, ,,
ε	9·730	3256	5542	Nebulous, strong.
	9·702	3294	5510	Nebulous, faint.
	9·695	3304	5501	Sharper than last, faint.
	9·680	3324	5485	Nebulous, faint.
	9·670	3338	5473	Sharp, faint.
	9·660	3352	5462	Very faint.
	9·635	3385	5435	Nebulous and faint.
	9·620	3406	5419	,, ,,
ε	9·595	3440	5392	Sharp.
	9·590	3447	5386	Sharp, faint.
	9·570	3474	5365	Very faint.

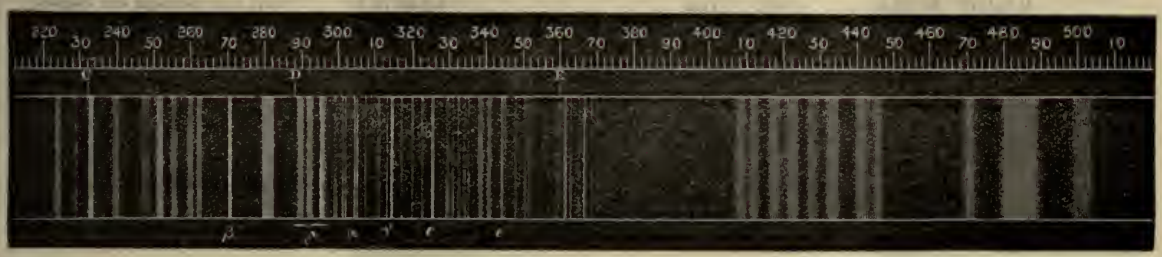


Fig. 1. Yttria. Phosphorescent spectrum.

The following table gives approximate measurements of the yttria lines shown in Fig. 1 :—

	Scale of spectroscope.	$1/\lambda^2$	λ.	
	10·440	2240	6681	Faint, nebulous.
	10·410	2283	6618	Very faint, nebulous.
	10·380	2328	6554	Faint, nebulous.
	10·335	2393	6464	Faint, nebulous.
	10·275	2481	6349	Nebulous, stronger than last.
	10·250	2518	6302	Stronger and sharper.
	10·225	2554	6257	Sharp, but not so bright as last.
	10·195	2598	6204	Very nebulous pair.
	10·180	2620	6178	
β	10·120	2707	6078	Sharp, very bright.
	10·050	2806	5970	Centre of an exceedingly faint nebulosity.
δ	9·990	2892	5880	Faint, nebulous.
δ	9·970	2920	5852	Brighter than last.
δ	9·950	2949	5823	Brightest part of a band shaded off towards the yellow.
	9·925	2984	5789	Faint, but sharp.
	9·905	3013	5761	Very faint pair.
	9·900	3019	5755	
α	9·8815	3045	5731	Very bright pair.
α	9·8793	3048	5728	
	9·550	3501	5343	,, ,,
	9·545	3507	5340	,, ,,
	9·480	3594	5275	Faint
	9·465	3615	5259	,,
	9·460	3622	5254	,,
	9·440	3648	5236	,,
	9·425	3668	5221	Strong, nebulous.
	9·410	3688	5208	Faint.
	9·400	3702	5197	,,
	9·100	4089	4945	Faint nebulous pair.
	9·070	4127	4922	
	9·030	4178	4892	Faint nebulous pair.
	8·990	4229	4863	
	8·950	4279	4834	Fainter nebulous pair.
	8·910	4329	4806	
	8·840	4416	4759	Fainter nebulous pair.
	8·800	4465	4733	
	8·600	4706	4610	Very nebulous, wide.
	8·540	4777	4575	Commencement of nebulosity.
	8·440	4896	4519	End of nebulosity.
	8·350	5001	4472	Very faint, nebulous.

The following table gives approximate measurements of the lanthana lines shown in Fig. 2 :—

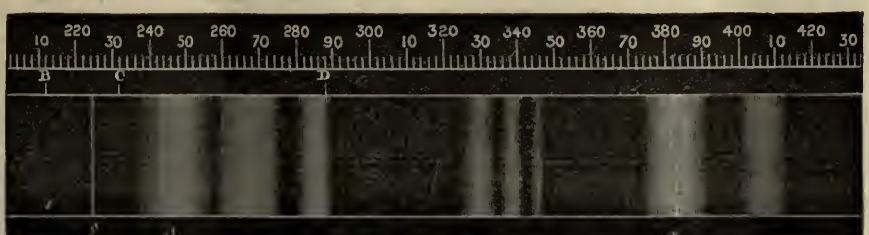


Fig 2. Lanthana. Phosphorescent spectrum.

	Scale of spectroscope.	$1/\lambda^2$	λ.	
γ	10·44	2240	6681	A tolerably sharp line, faint.
β	10·35	2371	6494	Approximate edge of very nebulous band.
	10·27	2489	6339	Point of maximum brightness.
	10·23	2546	6267	Approximate end of band.
	10·18	2620	6178	Approximate beginning of nebulous band.
	10·11	2720	6063	End of band.
	10·02	2850	5924	Centre of a nebulous band.
	9·70	3296	5508	Centre of a nebulous blue band.
	—	—	—	Here come two exceedingly faint bands which it is not possible to measure accurately.
α	9·30	3832	5108	Centre of an intensely bright blue nebulous band.
	9·11	4076	4953	Centre of a faint blue band.

RAPID METHODS FOR THE DETERMINATION OF SILICON, SULPHUR, AND MANGANESE IN IRON AND STEEL.*

By J. JAS. MORGAN.

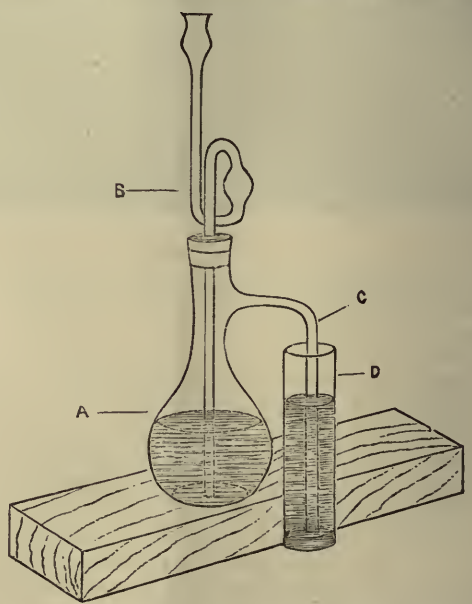
VERY often it is required to ascertain the chemical composition of a piece of iron or steel with the utmost despatch, and as the methods of analyses previously described in the author's articles on "Iron and Steel Analysis," whilst giving accurate results, occupy considerable time to perform, the author thought that an article giving abbreviated† methods, whereby the time occupied is considerably shortened, would be of service to the manufacturer, chemist, &c.

Two of the methods—viz., the estimation of silicon and sulphur, are due to Mr. John Parry, F.C.S., &c., chemist to the Ebbw Vale Iron Company, in whose laboratory they have been in use for a considerable period, giving every satisfaction.

Silicon.—Is estimated by what is termed the "roasting" process, which consists of heatiag in a muffle, at a bright red heat, a portion of the finely-divided sample, whereby the silicon is oxidised into silica, and any graphite present burnt off. Upon treating the roasted mass with hydrochloric acid all, with the exception of the silica, is dissolved; this is collected, burnt, &c. The quantity taken for analysis varies, according to the percentage of silicon in the iron—with irons containing 1 per cent or over 1 grm. is taken, under 1 per cent 4 grms. Having weighed out the quantity, place it in the muffle for twenty minutes. (The employment of too high a temperature and prolonged heating should be avoided, otherwise great difficulty will be experienced in dissolving the mass upon the subsequent treatment with acid). At the expiration of this time the dish, together with its contents, are withdrawn and allowed to cool. To prevent the mass of iron from sticking to the dish, which it is very apt to do, upon withdrawing from the muffle give it a gentle push with a glass rod, taking care not to lose any. In a beaker of 300 c.c. capacity place 100 c.c. of hydrochloric acid, and to this add, when cool, the mass of iron, brushing in any portions which may be attached to the dish; heat gently. When all besides the silica and, perhaps, a little graphite, if present, which may have escaped burning, is in solution, dilute with water, filter, wash well, burn, and weigh the silica, which should be of a white colour. The method, which was at first used solely for pig-irons, has been found by the author to answer equally well with steels.

Colorimetric Estimation of Sulphur.—It is well known that sulphuretted hydrogen, when passed through a solution of a lead salt, produces a brown colouration, varying in intensity according to the strength of the lead solution. By treating a sample with sulphuric acid, passing the evolved gases, sulphuretted hyrdogen, &c., through a dilute solution of lead acetate, and comparing the colour produced with that obtained by treating a standard steel, in which the sulphur has been carefuliy determined by the barium chloride method, in a similar manner a large number of determinations may be made in a very short time, and the samples classified, supposing the standard to contain 0·100 per cent of sulphur, as containing *over* or *under* 0·100, 0·075, 0·050, or 0·025 per cent of sulphur by taking portions of the standard solution and diluting with water until the desired strength is obtained. The solution of lead acetate is made by dissolving 0·200 grm. of the salt in one litre of water free from sulphates

The method is as follows:—0·500 grm. of the sample is weighed out and placed in the flask, A, and in the cylinder, D, 50 c.c. of the lead solution. Place on a hot plate, arranging the flask so that the tube C dips into the solution contained in the cylinder, and through the funnel, B, pour 60 c.c. of dilute sulphuric acid, made by adding



three parts of water to one of acid. When solution is complete the gas remaining in the flask is expelled by pouring in hot water, taking care to prevent it overflowing into the cylinder; withdraw the flask and compare the colour of the solution with that obtained by treating 0·500 grm. of the standard in a similar manner. As sulphuric acid forms a white precipitate of lead sulphate with lead acetate, it is essential that the apparatus be perfectly free from the acid, also to avoid using a high temperature, which would drive over some acid fumes.

With a lead solution of the strength mentioned the method is available for samples containing not over 0·18 per cent of sulphur, but by using a weaker solution, say half the strength, determinations up to 0·25 per cent may be made. The method is most suitable for determining whether the sample contains more or less sulphur than the standard solution, but with practice and the division of the standard into various strengths, as before mentioned, results agreeing within 0·01, and even less, of the percentage, as determined by the barium chloride method, may be obtained, which for general purposes is sufficiently accurate.

Manganese.—The method is a modification of Mr. Peters's, which is based upon the colour produced, due to

* Communicated by the Author. From the *Industrial Review*.

† Absolute accuracy is not claimed for the methods, but for general purposes they are sufficiently near.

the oxidation to permanganate, when lead peroxide is added to a solution of iron or steel in nitric acid containing manganese. In a test-tube, similar to that used for the estimation of carbon, place 0·200 grm. of the sample to be tested, and in a like tube the same quantity of a "standard" steel, in which the manganese has been carefully determined by weight. To each add 5 c.c. nitric acid, sp. gr. 1·20, and boil in a beaker of hot water until solution is complete. Cool the tubes, and to each add an equal bulk, about 2 c.c., of water; replace in the beaker, and, after boiling for a few minutes, add an excess of lead peroxide, which must be free from manganese, and ten drops of nitric acid, sp. gr. 1·42. After boiling for four minutes the tubes are withdrawn and placed in a beaker of cold water.

When the peroxide of lead has completely settled, transfer 2 c.c. of the clear supernatant liquid of the "standard" solution to the graduated tube used in the colorimetric estimation of carbon, dilute to 5 c.c. with cold water; mix. In a similar tube place the same quantity of the solution of the sample which is being tested, diluting with water until its colour is of the same intensity as that of the standard. Read off the number of c.c. to which dilution is carried, from which, by a simple proportion sum, the percentage is easily calculated.

The "standard" used should contain the same percentage, as near as possible, as the sample tested. If, after complete solution, cooling, &c., the carbon be estimated and the solutions made of equal bulk, peroxide of lead added, &c., as above directed, the same portions will suffice for the estimation of manganese and carbon. The acid used should be free from chlorine, otherwise the colour, which should be purple, will be destroyed.

As regards the estimation of phosphorus, the author recommends the "molybdate" process (for method see *Industrial Review* for May 28), it being, in his opinion, more *reliable*—in the hands of an expert operator—than the "magnesia" process. Some chemists object to it, on account of the phospho-molybdate precipitate being slightly soluble in hydrochloric acid, but ammonium-magnesium phosphate is also soluble both in its mother-liquor and in the water with which it is washed when on the filter. Thus a double loss is incurred. To remedy this loss by washing, ammonia-water is used, in which it is only slightly soluble. The loss or error in weighing the yellow precipitate does not make such a vast difference in the resulting percentage as with the magnesium precipitate, where a loss or error in weighing amounting to 0·002 grm. would equal a percentage of 0·0558, whilst with the molybdate process it would only amount to 0·0032. The whole secret of the "molybdate" process lies in having the right quantity of nitric acid present, which can only be arrived at after considerable practice.

QUANTITATIVE DETERMINATION OF GOLD AND ITS SEPARATION ESPECIALLY FROM THE PLATINUM METALS.

By L. HOFFMANN and G. KRÜSS.

The methods for the separation of gold from other metals which depend on its easy reduction have been submitted to close examination, as the current statements on this point are in part defective and in part inaccurate. The reducing agents which have been considered are sulphurous acid, oxalic acid, and ferrous chloride.

Before these separations were undertaken it was ascertained by especial experiments what degree of accuracy in the determination of gold can be reached by the reduction of its solutions, in order to form a precise opinion as to the trustworthiness of these methods, and as to the quantity of the platinum metals carried down in the preparation of pure gold. The gold employed had been carefully purified. Weighed quantities were dissolved in nitro-hydrochloric acid; the auric chloride was repeatedly evaporated down with pure hydrochloric acid until small quantities of gold began to separate out. The liquid was diluted and treated with the reducing agent. After precipitating the gold, washing, drying, and igniting, the weight was determined by observing the oscillations and interpolating. This seemed requisite, since the quantity of the possible contamination of the gold by platinum metals could be very small.

1. *Precipitation with Sulphuric Acid.*

The determination of gold by precipitating its solutions with sulphurous acid is not proposed in any accessible text-book of analytical chemistry. Rose, Fresenius, Menschutkin, von Miller-Killiani, Classen, recommend merely ferrous salts or oxalic acid for the precipitation of solutions of gold. This metal may, however, be quickly and accurately determined by the use of sulphurous acid. In the authors' experiments the gold found was 99·915 per cent of that taken.

It is advantageous not to use very highly dilute solutions, as otherwise the gold is thrown down in a very fine powder. The solutions, slightly concentrated if needful, are digested for about half an hour on the water-bath with aqueous sulphurous acid, until the liquid becomes perfectly clear, and, on the further addition of sulphurous acid, the smell remains. The gold can then be filtered at once, whilst the complete precipitation by ferrous chloride or oxalic acid requires a longer time. The determination with sulphurous acid has over the oxalic method the advantage of being more accurate, since the evolution of carbonic acid occasioned by the oxidation of the oxalic acid may easily occasion a slight loss by spirting. As compared with the ferrous chloride method it has the advantage that the gold is much more easily washed than that soiled with iron.

2. *Precipitation with Oxalic Acid.*

The gold was reduced by means of oxalic acid, with the aid of heat, until the addition of more acid produced after a considerable time no further separation of gold. The reduction was effected in a covered glass. The mean quantity of gold obtained was 99·88 per cent.

3. *Precipitation with Ferrous Chloride.*

The reduction was effected at a gentle heat on the water-bath, and after filtration the gold was completely washed with hydrochloric acid and hot water. The yield of gold was 99·96 per cent.

Of these three methods precipitation with oxalic acid occasioned the greatest loss of gold. Such loss is possible in any of the three methods, since the gold separates out here and there in such a fine state of division that traces of it may pass through the filter.

A method which avoids this risk, and yields in all cases —even if the solution is very dilute—precipitates easy to filter, is the precipitation of a solution of auric chloride with elutriated mercuric oxide. This method, first proposed by J. Volhard, gave 100·03 per cent of gold. The solution, after admixture with mercuric oxide, was gently heated on the water-bath, when the precipitate collects together in a gelatinous mass. The elutriated oxide had been obtained by decomposing mercuric chloride with the purest soda-lye prepared from metallic sodium. The mercuric chloride had been previously twice mixed with mercuric oxide, and sublimed.

Separation of Gold from the Platinum Metals.

Since many instances are known where the platinum metals do not behave the same with solvents and precipitants when mixed or alloyed as when existing separately, it could not be foreseen with certainty whether platinum, iridium, palladium, rhodium, and ruthenium, when accom-

panying gold in solution, are precipitated in small traces by the above reducing agents or not.

1. *Separation of Gold and Platinum.*

Hydrochloric solutions of auric chloride, containing a known proportion of gold, were mixed with neutral platinum chloride and reduced as above. The gold obtained with sulphurous acid was 100·54 per cent, with oxalic acid 100·005 per cent, and with ferrous chloride 100·24 per cent. Hence it appears that oxalic acid effects a complete separation of platinum from gold, whilst small quantities of platinum are carried down both by the sulphurous acid and the ferrous chloride processes. This was at once perceptible to the eye, since the two latter precipitates had not a pure gold colour, but were grey. This result was not to be expected, since Rose and Fresenius—in addition to the precipitation as double platinum-ammonium chloride—recommend only precipitation with ferrous chloride. "By this method of separation (with ferrous chloride)," says Rose, "a very accurate result is obtained."

According to the above analyses the gold precipitated by ferrous chloride is platiniferous. This agrees with the fact that platinum chloride is partially reduced by ferrous sulphate, though only on prolonged boiling.

The gold thrown down by sulphurous acid also contained platinum, which, after weighing and re-dissolving the product, could be obtained as the double ammonium chloride.

To separate gold in solution from platinum by means of oxalic acid is, according to Rose, not advisable. The above analyses show, on the contrary, that gold may be most safely separated from platinum by means of oxalic acid.

2. *Separation of Gold and Iridium.*

Solutions of auric chloride were mixed with solutions of sodium and iridium chloride, free from acid. The latter salt was selected because finely divided or alloyed iridium dissolve only in insignificant quantities in aqua regia. Iridium black was mixed with two equivalents of sodium chloride, and ignited in a current of chlorine gas; the product was left for about eight days over fresh soda-lime, treated with water, and separated by filtration from undissolved indium. Precipitation with sulphurous acid gave 100·005 per cent of gold, with oxalic acid 99·975 per cent, and with ferrous chloride 99·94. Gold and iridium may therefore be completely separated either by sulphurous acid, oxalic acid, or ferrous chloride.

3. *Separation of Gold and Palladium.*

The solutions of auric chloride were mixed in five cases with solution of crystalline potassium-palladium chloride, and in three with the mixture of palladious and palladic chloride, obtained by dissolving palladium in aqua regia, and repeatedly evaporating down with hydrochloric acid until all acid was expelled.

On precipitation with sulphurous acid the mean percentage of gold obtained was 99·96; with oxalic acid the quantities varied from 99·62 to 100·48, and with ferrous chloride from 99·85 to 100·62.

Sulphurous acid effects, therefore, a complete separation of gold and palladium, whilst oxalic acid and ferrous chloride give a result which varies according to circumstances.

4. *Separation of Gold and Rhodium.*

Finely divided rhodium was converted into chloride by ignition in a current of chlorine: the chloride was mixed with two parts of sodium chloride, and again heated in a current of chlorine. The product, freed from uncombined chlorine, dissolved almost completely in water as rhodium-sodium chloride, and was added to solutions of auric chloride of a known strength.

With sulphurous acid the mean percentage of gold was 100·035, with oxalic acid 99·83, and with ferrous chloride 100·025 per cent. All these methods can therefore effect a complete separation of gold from rhodium.

5. *Separation of Gold and Ruthenium.*

Metallic ruthenium was converted into a double sodium chloride, similarly to iridium, and the clear neutral solution was added to auric solutions of known strength.

With sulphurous acid the mean yield of gold was 99·945 per cent, with oxalic acid 99·92, and with ferrous chloride 99·93. All these agents therefore effect a complete separation of gold and ruthenium.

Hence it appears that gold can be fully separated from platinum only by oxalic acid, from palladium only by sulphurous acid, but from iridium, rhodium, and ruthenium by all three reducing agents. The separation of osmium and gold was ignored, since osmium cannot be present in solutions of gold evaporated down in aqua regia. Under these conditions osmium evaporates quantitatively as tetroxide.—*Liebig's Annalen*, Vol. ccxxxviii., p. 66.

NOTES ON THE USE OF IRON SULPHATE IN AGRICULTURE.

By Dr. A. B. GRIFFITHS, F.R.S. (Edin.), F.C.S. (Lond. and Paris).

The readers of the Chemical News are acquainted with my published papers on the use of ferrous sulphate for agricultural purposes. Perhaps the following notes may be of interest:—

I. *Grass Land infested with Moss.*

In my paper (*Journ. Chem. Soc.* [*Trans.*], 1886, p. 114) it was shown that iron sulphate completely destroys moss in grass land infested with it, but does *not* destroy the grass. The reasons for this are given in that paper. I have received a letter from M. P. Marguerite-Delacharlonny (a well-known scientist of Paris) confirming these results. He says:—

"J'ai employé ($FeSO_4$) pour la destruction des mousses et avec succès égale 250—350 kilogrammes par hectare; avec 100 kilogrammes la destruction est incomplète."

Mr. J. J. Barlow (Oak Lane Farm, Whitefield, Manchester) has also obtained similar results upon grass land infested with moss.

II. *Iron Sulphate* versus *Parasitic Fungi.*

Iron sulphate is now established as a destroyer of parasitic fungi (Chemical News, vol. xlix., p. 279; *Journ. Chem. Soc.* [*Trans.*], 1886, p. 119; Chemical News, vol. liii., p. 255; vol. lv., p. 276; and *Chemiker Zeitung*, No. 47). One of the pests of this year to our farm crops is a micro-fungoid growth which causes tubercular swellings upon the roots of *Vicia faba* (bean). About three months ago I was informed that in the neighbourhood of Etton, near Peterborough, the crops of winter beans have been this year a failure. Mr. G. W. Edgson (a large agriculturist) kindly sent me a number of bean plants for inspection. They were about 7 inches in length, and I have preserved several in weak alcohol. Mr. Edgson says in his letter:—

"The roots of the winter beans you will find are covered with small boils, which appear to be living upon the plant, and have kept the bean plants in the stage you now see them. For the last few months the crop in this district has been a failure. Not having seen anything like it before, I thought it would be interesting for you to see them."

I found (from a microscopical study), upon the roots of the bean plants, tubercular swellings which are due to the growth of a parasitic fungus with small spores. The mycelium of this bean-root fungus and also its spores are destroyed by iron sulphate On treating the hyphial filaments of the fungus and its spores with a solution of iron sulphate upon a slide under the microscope, one could see the perforation of the cellulose walls of the organism, exactly in the same way as I have so often observed in cases of microscopic fungi generally.

I see that Prof. H. Marshall Ward, M.A., F.L.S., has published a paper (read before the Royal Society, June 16th, 1887) on the subject, and he informed me that he is making a complete study of this fungoid growth. I sent, about two months ago, specimens of the roots of *Vicia* from the district of Etton, with a rough drawing of a microscopical slide I have prepared of this root fungus, to Prof. Ward.

III. *Iron Sulphate for Vines.*

As yet I have not made any experiments on the value of iron sulphate as a manure for vines. It is stated in a pamphlet which I possess concerning Australian wines, that "the Tintara vineyard was originally planted by an early settler, the late A. C. Kelly, M.D., and its position was selected on account of the *ferruginous* constituents of the soil at Maclaren Vale." On the other hand, I have been reminded that, "in the vineyards of Lorraine, the vines growing in the soil overlying the ironstone mines are anything but satisfactory, either in growth or quality."

It is well known that an *excess* of iron in a soil may cause a soil to become barren. It will be remembered that the late Dr. Voelcker, F.R.S., found that certain soils in Hampshire and Bedfordshire were completely sterile on account of the iron sulphate and iron pyrites which they contained amongst the other constituents of the soils. To answer this point I will quote from a pamphlet kindly sent to me by Dr. Munro, F.C.S. ("Report by Prof. Wrightson and Dr. Munro on the Manurial Value of Basic Cinder," p. 20):—

"A sample of soil sterile from the presence of sulphate of iron was found by the late Dr. Voelcker to contain 0·7 per cent of that substance. Now, if the soil were only 4 inches deep and of average density this would amount to *four tons of sulphate of iron per acre*, and it does not at all follow, from the sterility of this soil, that a dressing of ½ cwt. or 1 cwt. per acre of green vitriol, applied in a manure, would cause the slightest damage to any crop."

I have always recommended ½ cwt. of ferrous sulphate to the acre as a top-dressing. On the other hand, my brother, Mr. E. A. Griffiths (British Vice-Consul at Nagasaki, Japan) informed me some time ago that Dr. O. Kellner, of the Imperial College of Agriculture of Tokyo, Japan, was working upon the same subject; and I see, from *Landwirthschaftliche Versuchs-Stationen*, 1886, pp. 365—370, that in 1833 he conducted experiments with ferrous sulphate in *varying quantities*, when *no* harmful influence on the plants in any stage of their growth was observed.

I intend to experiment with vines, using iron sulphate as a manure.

There are five rather long essays on the "Effets utiles du Sulfate, de Fer en Agriculture," by Marguerite-Delacharlonny, in the *Journal de l'Agriculture* for May 14th, 21st, June 4th, 11th, and 18th, 1887.

6, Rue de Bagneux, Faubourg St. Germain,
Paris, August 15, 1887.

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 77).

5. *Samarium and Praseodymium Material.*

The samarium material was derived from different minerals; it contains Sm‴ of the atomic weight 150·0, and yielded, in a nitric solution, Spectrum V.

As for the praseodymium material, it also had been obtained from various minerals. It yielded, like Auer von Welsbach's praseodymium, a greenish nitric solution. Its spectrum was composed as in Table VI.

6. *Fergusonite from Arendal and Ytterby.*

As formerly communicated in the *Berichte* (xx., 1676), considerable quantities of rare earths had been amassed by occasion of a study on the rare earths and the niobic acid of Fergusonite. This material, which was obtained from 2 kilos. Fergusonite from Arendal, was resolved (by a decomposition of the nitrates twelve times repeated) into different fractions, which contained the earths arranged in the order of their basicity. The nitric solu-

V. *a. Samarium from Cleve.*

Observed position of maximum darkness.		Wave-lengths formerly observed.	For.	Intensities of bands.
Position of Telescope-drum.	Wave-length observed.			
2595	579·6	579·2	Di	Faint.
2604	575·8	575·4	Di	Very faint.
2645	558·7	559—556	Sm	Faint.
2725	528·1	530·0	Di	Extremely faint.
2749	521·0	521·5	Di	Extremely faint.
2825	500·4	501·5—497	Sm	Rather strong.
2863	489·1	—	(?)	Very faint.
2882—2920	483—475	486—472	Sm	Extremely strong.
2970	463·3	466—460	Sm	Very strong and well defined.
3030	452·9	453—449	X	Extremely faint.
3080	443·5	444·7	Di	Strong with indefinite margin.
3240	417·4	416·7	Sm	Very strong.
3300	409	409	Sm	Faint.

VI. *b. Praseodymium from Cleve.*

2353	729·0	728·3	Di	Strong.
2420	679·3	679·4	Di	Scarcely perceptible.
2568	591·5	591·5	Di	Faint, broad.
2595	579·6	579·2	Di	Strong.
2604	575·8	575·4	Di	Rather strong.
2712	531·6	531·3	Di	Scarcely visible.
2747	521·6	521·5	Di	Rather strong and definite.
2780	512·5	512·2	Di	Faint, broad, misty.
2887	482·5	482·0	Di	Very sharp and intense, but narrow.
2943	469·4	469·0	Di	Rather strong.
3076	444·2	444·7	Di	Very strong.

VII. *a. Fergusonite from Arendal.*

Position of maximum darkness.		Wave-lengths formerly observed.	For.	Intensity of Bands in Spectra of Fractions.				
Position of Telescope-drum.	Wave-length.			Fraction I.	Fraction II.	Fraction III.	Fraction IV.	Fraction V.
2354	728·3	728·3	Di	Strong.	Rather strong.	Faint.	Extremely faint.	—
2382	707·5	708·2	Di	Extremely faint.	—	—	—	—
2415	683·2	684·0	Tm	—	—	—	—	—
2420	679·3	679·4	Di	Very faint.	Faint.	Faint.	Faint.	Very faint.
2456	654·2	654·7	Er	Stronger.	Strong.	Strong.	Strong.	Rather strong.
2567	592·0	591·5	Di	Extremely faint.	Extremely faint.	—	—	—
2595	579·6	579·2	Di	Very strong.	Strong.	Very faint.	—	—
2606	575·0	575·4	Di	Strong.	Rather faint.	Extremely faint.	—	—
2682	542·6	542·6	X	Faint.	$\lambda=536{\cdot}3$ stronger than $\lambda=542{\cdot}6$. Both bands > in I.	$\lambda=536{\cdot}3$ stronger than $\lambda=542{\cdot}6$.	$\lambda=536{\cdot}3 > \lambda=542{\cdot}6$; both stronger than III.	As in IV.
2699	535·3	536·3	X	Rather strong.				
2740	523·6	523·1	Er	Strong.	Very strong.	Very strong.	Strong.	Medium strong.
2747	521·6	521·5	Di	Strong, weaker than $\lambda=523{\cdot}1$.	Strong.	Strong.	Medium strong.	Faint.
2782	512·0	512·2	Di	Faint.	Very faint.	—	—	—
2872	485·9	485·5	X	Rather strong.	Strong.	Strong.	Strong.	Stronger than $\lambda=536{\cdot}3$.
2920	474·9	474·5	X	Strong as $\lambda=536{\cdot}3$.	Weaker than $\lambda=536{\cdot}3$.	Rather faint.	Extremely faint.	Scarce visible.
2943	469·4	469·0	Di	Extremely faint.	Scarcely visible.	Extremely faint.	Extremely faint.	—
2974	46 ·3	463·2	Sm	Very faint.	Extremely faint.	—	—	—
3030	452·3	453—449	X	Very strong.	Strongest line of the whole spectrum.	As in II.	As in II.	As in II.
3074	444·6	444·7	D	Faint.	Faint.	Very faint.	Very faint.	Extremely faint.
3165	428·5	428·5	X	Very faint.	Faintest of all X lines of this spectrum.	Very faint.	Extremely faint.	—
3240	417·3	416·7	Sm	Very strong.	Strong.	Rather strong.	Medium strong.	Rather strong.

VIII. *b. Fergusonite from Ytterby.*

Observed position of maximum darkness.		Wave-lengths formerly observed.	For.	Intensities of bands.
Position of Telescope-drum.	Wave-length observed.			
2353	729·0	728·3	Di	Rather strong.
2420	679·4	679·4	Di	Extremely faint.
2456	654·2	654·7	Er	Rather strong.
2480	640·6	640·4	X	Rather faint.
2505	626·1	626·1	Di	Extremely faint.
2567	592·0	591·5	Di	Very faint.
2595	579·6	579·2	Di	Very strong.
2606	575·0	574·4	Di	Strong.
2682	542·6	542·6	X	Rather strong.
2699	535·3	536·3	X	As strong as foregoing.
2705	533·6	—	(?)	Faint, but well defined.
2740	523·6	523·1	Er	Very strong.
2747	521·6	521·5	Di	Strong.
2782	512·1	512·2	Di	Faint.
2872	485·9	485·5	X	Strong.
2920	474·9	474·5	X	Very faint.
2943	469·4	469·0	Di	Scarcely perceptible.
2974	462·3	463·2	Sm	Very faint.
3023	452·6	453—449	X	Very strong; strongest line of spectrum.
3076	444·2	444·7	Di	Very faint.
3163	428·9	428·5	X	Faint.
3240	417·3	416·7	Sm	Strong.

tions of the twelve fractions have very different spectra, and it is interesting to see how the relative intensity of the absorption-bands fluctuates in the spectra of the several fractions. From the following tables it is apparent that several bodies, hitherto regarded as elementary, consist of several components (See Table VII.).

The earths which had been obtained from 1¼ kilo. Fergusonite from Ytterby were not further separated by fractionated decomposition of the nitrates, but were at once examined in a nitric solution (See Table VIII.).

In the spectrum of the Fergusonite from Ytterby there are several lines of didymium and of Soret's X, which

a. Fergusonite from Arendal (continued).

Intensity of Bands in Spectra of Fractions.

Fraction VI.	Fraction VII.	Fraction VIII.	Fraction IX.	Fraction X.	Fraction XI.	Fraction XII.
—	—	—	—	—	—	—
—	—	—	—	—	—	—
Faint.	Stronger than in VI.	Rather strong.	Rather strong.	Weaker.	Faint.	Scarce visible.
—	—	—	—	—	—	—
Rather faint.	Rather faint.	As in VII.	As in VII.	Weaker.	Very faint.	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
Rather faint; $\lambda=536{\cdot}3$ rather stronger than $\lambda=542{\cdot}3$	Both X lines equally strong.	$\lambda=542{\cdot}6$ rather stronger than $\lambda=536{\cdot}3$	$\lambda=542{\cdot}6$ still stronger than $\lambda=536{\cdot}3$; both lines faint.	Very faint.	Extremely faint.	—
				—	—	—
Rather strong.	Rather strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Rather stronger than the Tm line of this fraction.
Faint.	Faint.	Very faint.	Very faint.	—	—	—
—	—	—	—	—	—	—
Rather strong.	Rather strong.	Rather strong.	Rather strong.	Fainter.	Faint.	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
Strongest line of spectrum.	As in VI.	As in VI.	As in VI.	Fainter.	Faint broad band.	—
Extremely faint.	Extremely faint.	Extremely faint.	—	—	—	—
—	—	—	—	—	—	—
Very faint.	Very faint.	—	—	—	—	—

could not be detected in the spectrum of the Fergusonite of Arendal. On the other hand, there were found in the material from Arendal considerable quantities of thulium, which was not observed in the Fergusonite of Ytterby. In the spectrum of the earths of the latter mineral there was seen a line at $\lambda = 533{\cdot}6$, which was otherwise found only in the absorption spectrum of the euxenite earths of Hitterö, though it could not be identified with any of the lines characteristic of the nitrates of the rare earths.

(To be continued).

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

ALCOHOLIC EXTRACTS.

Extract (1), *Bark of the Root.*

THE residual powder from the ether extraction was dried, and replaced in the percolator. The maceration was conducted at the boiling temperature of alcohol. Squibb's stronger alcohol was used. A dark red-coloured liquid was extracted. It was neutral in reaction with litmus. The *alcoholic extract* was evaporated in a current of carbonic acid. The *residue* was non-crystalline and of a red colour. A definite volume of the *alcoholic extract* was evaporated, dried until the weight remained constant, and the *residue* incinerated in a weighed platinum dish and the ash estimated.

I.

Total Solids.

Alcoholic residue dried at 100° C.	9·25	per cent
" " " 110° C.	9·25	"
ash	0·2	"

The *alcoholic residue* was treated with distilled water, and a definite volume of the extract was evaporated, dried, and weighed. The *alcoholic residue* insoluble in water was treated with water containing ammonia (one part in fifty). This ammoniacal extract was evaporated with excess of acetic acid, and the residue rinsed with a little water on a filter, dried, and weighed. The dried aqueous extract insoluble in ammonia was then estimated.

II.

Distilled water residue	3·22	per cent.
Ammonia " "	5·43	"
Insoluble " "	0·60	"
Total solids	9·25	"

The aqueous extract from the *alcoholic residue* was studied as follows: It was not coloured by a ferroso-ferric salt nor precipitated by gelatin and alum solutions, showing absence of gallic acid and tannin. A portion of the aqueous extract was acidified with sulphuric acid and agitated successively with petroleum spirit, benzol chloroform, and amyl alcohol. The acidified liquid was rendered alkaline by ammonia and agitated with the solvents in the same order. Petroleum spirit removed from the acidified solution traces of an amorphous residue,

* Reprinted from the *Transactions of the American Philosophical Society.*

soluble in sulphuric acid and caustic soda. Benzol and chloroform separated no substances from the solution. As the amyl alcohol solution was evaporating white needle-shaped crystals were seen floating in the liquid. On drying the residue they were decomposed and melted, leaving a dark-coloured liquid. Several attempts were made to dry these crystals, without success. A few of the crystals were recovered from the solution, and tested for alkaloids; no reactions were obtained with the usual reagents for them.

Glucose was estimated from the aqueous extract. The liquid was heated over a water-bath with Fehling's solution, and the precipitated red cuprous oxide was thrown upon a weighed filter, dried, and incinerated. The glucose was estimated gravimetrically by calculating the amount of cupric oxide. It yielded 0·619 per cent. A portion of the aqueous extract was boiled with acid, neutralised, and heated over a water-bath with Fehling's solution to calculate, by difference, saccharose or other reducible compounds, and by this method 0·18 per cent was obtained.

The *alcoholic extract* was described as being deeply coloured. This colouring principle* was completely precipitated by sub-acetate of lead. The lead precipitate was collected on a filter, suspended in water, and decomposed by sulphuretted hydrogen, filtered, and the filtrate freed from all odour. It was allowed to evaporate slowly over sulphuric acid. The residue was a brownish grey mass, interpersed with fine crystals which radiated from a nucleus. The mass was weighed and gave 3·27 per cent of solids. Another portion of the *alcoholic extract* was agitated with water and acetic ether. The colouring matter was taken up by the acetic ether, and on evaporating a red-coloured substance was recovered. It was dried and weighed, yielding 2·2 per cent. This red-coloured residue was perfectly soluble in cold water. This solution was tested with the following reagents: It gave with potassium bichromate a creamy-coloured precipitate; ferric chloride, a yellowish green precipitate; ferrous sulphate, a reddish brown precipitate; stannous chloride, no precipitate, a yellow cloudy liquid; alum, a cloudy solution; neutral acetate of lead, a slight precipitate. The red colour of the colouring matter was brought out on addition of alkalies. It was destroyed by acids.

Extract (2), *Wood of the Root.*

The residual powder from the ether treatment was dried and macerated with Squibb's stronger alcohol. The *alcoholic extract* was neutral in reaction; when warm it was a clear reddish golden-coloured liquid. On cooling, a creamy-white solid settled at the bottom of the flask. This substance was soluble in water, and was identified as saponin by the usual tests for it. A definite volume of the *alcoholic extract* was evaporated in a current of carbonic acid, dried, and weighed. The residue was incinerated in a weighed platinum crucible for the ash determination.

Total Solids.

Alcoholic residue dried at 100° C.	14·3 per cent.
,, ,, ,, 110° C.	14·3 ,,
ash	0·1 ,,

The *alcoholic residue* was treated with cold water, in which it was soluble. A cloudy solution was formed, and on shaking, it became frothy, and presented the appearance of an emulsion. It was allowed to stand for several days to see if the resinous matter separated, but the emulsion was permanent, as no separation had taken place. The emulsified liquid was agitated with acetic ether, and this solvent readily separated most of the resin from the aqueous portion. The water extract was then evaporated to dryness and re-dissolved in water. Gelatin and alum solution did not precipitate the extract, showing absence of tannin; no colouration with iron salts, absence of gallic acid; negative results followed tests for alkaloids; the aqueous extract was boiled with potash and no ammonia fumes were formed; adding gold chloride, and potassio-mercuric iodide solutions to the extract gave no precipitate. A measured portion of the aqueous extract was acidified with sulphuric acid, and agitated successively with petroleum spirit, benzol, and chloroform. The solvents were evaporated; petroleum spirit removed 0·01 per cent of a resinous substance, imperfectly soluble in cold and boiling aqueous alkalies, dissolved by sulphuric acid with a red colouration; chloroform left a brownish residue which, on weighing, yielded 0·4 per cent. This residue was moistened with a few drops of concentrated sulphuric acid, and changed to a red-violet colour characteristic of saponin.

A certain portion of the aqueous extract was rendered alkaline, and heated over a water-bath with Fehling's solution. The precipitated copper was collected on a weighed filter, dried, and incinerated, and the glucose estimated gravimetrically from it. It yielded 1·592 per cent. Another portion of the aqueous extract was acidified, boiled, and potash added until the solution was alkaline to litmus paper, then the liquid was mixed with Fehling's solution and heated over a water-bath. The percentage of saccharose or other substances which reduced the copper was calculated by difference. It amounted to 0·929 per cent.

The resin separated by acetic ether was an opaque substance, greenish yellow in colour, and insoluble in ether. The resin was dissolved in water and frothed on shaking. The emulsion in this case was not quite so permanent, as a slight resinous sediment settled after a time, possibly due to changes in the resin through oxidation.

Extract (3), *the Green Part of the Leaf.*

The dried residual powder was macerated by the aid of heat with Squibb's stronger alcohol. When warm the *alcoholic extract* was clear, but on cooling the solution became cloudy, and a creamy-white fine precipitate settled. The *alcoholic extract* was neutral in reaction. It was evaporated in a current of carbonic acid, dried, and weighed. A certain part of the residue was incinerated and the ash determined.

Total Solids.

Alcoholic residue dried at 100° C.	3·80 per cent.
,, ,, ,, 110° C.	3·80 ,,
,, ,, ash	0·15 ,,

The *alcoholic residue* was treated with cold distilled water. It had a slightly acid reaction with litmus. An emulsion was formed on the addition of water to the *alcoholic residue*. A measured quantity of it was evaporated, dried, and weighed. It amounted to 3·4 per cent; 0·4 per cent of the *alcoholic residue* was insoluble in water. Tannin, gallic acid, and alkaloids were tested for and with negative results.

The liquid from the aqueous treatment of the *alcoholic residue* was rendered alkaline, and boiled with Fehling's solution, and there was no reduction. Bœttger's bismuth test was also tried and with negative results. The aqueous portion was boiled with acid and examined in the usual way for glucosides; the results were negative.

One volume of the aqueous solution was mixed with three volumes of stronger alcohol. It was placed on ice, and after some time a white precipitate formed. The precipitate was collected and dissolved in water. It frothed on shaking. On addition of a concentrated solution of caustic baryta, a creamy-white precipitate of saponin-baryta was obtained. Sulphuric acid gave the usual red-violet colour reaction with the precipitate from the alcoholic aqueous solution.

The method of successive agitation of an aqueous extract with solvents already described was followed. Petroleum spirit on evaporating left a resinous substance. The residue separated by chloroform from an acidified solution

* A red crystalline colouring matter. *Science*, September 11, 1885

was a brownish coloured substance. It was soluble in water, and frothed on shaking. It was coloured red violet by sulphuric acid, and the aqueous solution was precipitated by barium hydrate. Chloroform separated a brownish solid from an alkaline aqueous solution. It was precipitated by barium, coloured red-violet by sulphuric acid, and its aqueous solution frothed on shaking. This brownish residue was identified as saponin.

Extract (4), *the Yellow Base of the Leaf.*

The residual powder, dried from all traces of ether, was macerated with hot alcohol. The *alcoholic extract* was a currant-coloured liquid, and slightly acid in reaction. The liquid became clear on standing, and a creamy-white solid, identified as saponin, separated from it. The *alcoholic extract* was evaporated, dried, and weighed, and the ash of the residue was estimated.

Total Solids.

Alcoholic residue dried at 100° C.	4·30	per cent.
,, ,, ,, 110° C.	4·30	,,
,, ,, ash	0·05	,,

The *alcoholic residue* was treated with cold distilled water. The solution was slightly coloured, and faintly acid in reaction. The absence of gallic acid, tannin, and alkaloids was determined by negative results with iron salts, gelatin and alum solution, gold chloride and potassio-mercuric solutions. Acetate of lead caused no precipitation. Fehling's solution detected a trace of glucose.

An imperfect emulsion formed on adding water to the *alcoholic residue*. Upon standing, the resin settled; the liquid was filtered several times, and the greater part of the resin collected. It was an opaque reddish yellow coloured substance. It had the same melting-point (79° C.), solubilities, and physical appearance as the resin of *ether extract* (4). The resin was examined by Hirschsohn's scheme. It differed in character from the many resins described by that author, and it is proposed to name it pyrophæal.*

Pyrophæal was slightly soluble in ether and 95 per cent alcohol; soluble in benzol, chloroform, and acetic ether; incompletely soluble in cold absolute alcohol, amyl alcohol, carbon disulphide, and oil of turpentine. It was saponified with aqueous and alcoholic soda. The ethereal resin solution was cloudy. The alcoholic resin solution gave a precipitate with lead acetic which did not disappear on boiling; ferric chloride and aqueous ammonia formed turbid mixtures with it. The chloroform resin solution was not affected by bromine solution. The petroleum-ether-resin solution turned to a turbid mixture on adding iodine solution. Alcohol containing hydrochloric acid was not coloured by the resin. Sulphuric acid and alcohol gave a turbid brown mixture with it, and sodium carbonate solution was coloured pale brown when cold or on warming.

(To be continued).

NOTICES OF BOOKS.

Technical School and College Building: being a Treatise on the Design and Construction of Applied Science and Art Buildings, and their Suitable Fittings and Sanitation; with a Chapter on Technical Education. By Edward Cookworthy Robins, F.S.A. London: Whittaker and Co.

We have here an original, and we must say an exceedingly valuable, work, which we trust will meet with sufficient appreciation to remunerate the publishers for the very heavy expenditure they must have incurred in bringing it out. The changes which are taking place in the character of higher education involve a corresponding modification in the structure of school and college buildings. So long as instruction had to be given merely or mainly in words and abstractions, almost any kind of rooms would answer the purpose if only—which was not always the case—duly lighted, warmed, and ventilated. But so soon as *things* became the objects of study,—so soon as a thorough training in the natural and physical sciences was found to be necessary,—colleges had to be fitted with laboratories (chemical, physical, and biological), with museums, model-rooms, and a variety of other appliances. To contrive and arrange these with full regard both to efficiency and economy was found to be a task not within the scope of the ordinary architect. Here, therefore, is the *raison d'être* of Mr. Robins's work. He has made a careful study of the chief college buildings, technical schools, laboratories, &c., at home and abroad, of which he has given numerous plans, elevations, and sections, drawn to scale and accompanied with very full descriptions. Hence to the trustees or directors of colleges, &c., desirous of enlarging or re-modelling the working portions of their premises, as well as to their architects, the work will be simply priceless. In our opinion Mr. Robins merits the gratitude of all friends of higher education for the manner in which he has executed his task.

The third chapter, illustrated with ten elaborate plates in addition to woodcuts, gives an account of foreign buildings for science and art instruction. We note the expression "applied science" used by the author, which is not in all cases strictly correct, since some of the institutions figured and described are devoted to pure science, irrespective of any applications.

It may be instructive to consider the sums spent on the University of Strassburg,—quite a third-class city as regards its size and wealth. "Towards the total sum of £640,000 expended on this University up to 1885, the German Empire has contributed £190,000; of this sum £115,000 were spent on the Collegiate Palace. The Institute of Chemistry alone cost £35,000; the Institute of Physics, £29,150; the Institute of Botany, with its garden, £26,200; the Astronomical Observatory, £25,000; the Institute of Anatomy, £41,740; the Surgical Clinical Hospital, £26,500; the Institute of Physiological Chemistry, £16,000; and the Institute of Physiology, £13,500.

The Institutes of Geology, Zoology, and Meteorology have yet to be erected and fitted up. The cost of the library of 560,000 volumes is not included in the above estimates, and reached £71,400.

May we be permitted to say that, if we wish to be on an equal footing with Germany in the cultivation of science, we ought to have universities at least equally well equipped, in Liverpool, Manchester, Birmingham, Leeds, Sheffield, Newcastle-on-Tyne, Edinburgh, Glasgow, Dublin, Belfast, besides an institution in London of far greater calibre, and a vast development of the ancient universities of Oxford and Cambridge?

It is to be deplored that wealthy men in this country are willing to give thousands for the purposes of faction, rather than for institutions to promote the general prosperity of the country.

In Chapter IV. the author gives a corresponding account, on a still larger scale, of English laboratories, &c.

We next come to two chapters on the fittings required for applied science instruction buildings. These chapters will also be found exceedingly useful.

Chapters VII. and VIII. discuss the heating and ventilation of laboratories, &c. Chapter IX. treats of the planning of buildings for middle-class education generally, and Chapter X. deals with sanitary science in its relations to civil architecture.

The first two chapters of the work, however, have little connection with the building or fitting up of colleges or laboratories, but are devoted to a survey of English and foreign technical education, and to an analysis of the Second Report of the Royal Commissioners on Technical

* Pyrophæal. *Science*, September 11, 1885.

Education. In these chapters, which would require great space for full discussion, we find much that we can unhesitatingly approve, but also no little upon which we are compelled to pause.

The account given of the establishments for higher education in Germany is, so far as our own observation and the information at our command extend, very correct, But we find it strange that neither Mr. Robins himself nor the eminent authorities whom he cites seem to take into account the main differences between the German and the English systems of education, to the disadvantage, as it seems to us, of the latter. Germany is free from the vicious custom of payment by results, falsely so called, and from competitive examinations. Indeed in Germany examinations play a very much smaller part in education shan they do in England. The great object among German professors is to train their students for research, whilst the great object of the English "coach," or "grinder," is to make his pupils pass. Prof. Huxley's memorable dictum should never be forgotten. Said this eminent *savant*—"In these days we study not to know, but to pass, and consequently we pass and don't know." It is therefore with much regret that we see "payment by results" still recognised in the "recommendations" embodied in the "Second Report on Technical Education."

For the views cited in this second chapter Mr. Robins cannot be held responsible, and the value and utility of his work will be evident on careful inspection to every competent reader.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 4, July 25, 1887.

Fluorescences of Manganese and Bismuth. Remarks or Conclusions.—Lecoq de Boisbaudran.—The author specifies a number of conditions under which fluorescences are modified. He remarks that certain fluorescences, masked by others, may be detected either on heating the tube or by observing after the cessation of the current, or by modifying the intensity of the current.

Direct Preparation of Two Inactive Borneols, yielding, on Oxidation, Dextro- or Levo-Camphor.—Alb. Haller.—Borneols may be obtained by the hydrogenisation of camphors. They may be prepared either by the process of Berthelot, or by that of Baubigny, or by the method devised by Jackson and Mencke, and modified by Wallach. Whatever is the process of hydrogenisation employed, there has never been obtained a single stable camphol; it is always mixed with an unstable variety.

Action of Aniline upon Bibromised Diethyl-succinic Ether.—N. Lopatine.—The author boiled for twelve hours 10 parts of the above ether with 20 parts of aniline and 40 parts of alcohol at 95 per cent in a flask fitted with a reflux condenser. At the end of the reaction the mass solidifies. When cold it is treated with cold alcohol, which dissolves a part of the product with a deep brown colour. The residue is taken up in boiling alcohol, which deposits a new compound in long silky needles. The author is engaged with the further study of this compound.

Zeitschrift für Analytische Chemie. Vol. xxvi., Part 1.

Fat for Greasing the Edges of Beakers.—A. Gawalowski.—Instead of tallow, &c., the author recommends, in case of alkaline liquids, solid paraffin, and for solutions in ether, petroleum ether, or similar liquids, starch paste, gum-arabic, dextrine, &c. (We do not know who first proposed solid paraffin for greasing the lips of beakers, but it was in use in England seventeen years ago).

An Absorbent for Oxygen.—Otto Baron von der Pfordten.—From *Liebig's Annalen.*

Determination of Lithium with the Spectroscope.—Foehr.—H. Ballmann published a method in this *Journal* (xiv., p. 297), which appears to have been independently re-discovered by L. Bell (See *Am. Chem. Journal*, vii., 35, and *Berichte Deutsch. Chem. Gesellschaft*, xviii., 2897). Foehr modifies the original process of Ballmann by adding to a litre of distilled water a mille-normal solution by means of a burette until a drop of the mixture on a platinum wire shows the line L : α. If the same experiment is then conducted with the solution under examination, the proportion of lithium appears from the volume used.

Reactions of Indium.—Lecoq de Boisbaudran.—From the *Comptes Rendus.*

Electrolytic Quantitative Analysis.—A. Classen and R. Ludwig.—The authors separate antimony from arsenic as follows:—The mixture of both metals or their compounds is completely evaporated down with aqua regia, the residue is dissolved in 2 to 3 c.c. water, pure strong soda-lye is added in such a proportion that 1 grm. NaOH may be contained in the liquid, 60 c.c. of the sodium sulphide solution described in this *Zeitschrift* (xxv., 103) are added, and the process is continued exactly as described (p. 102) for separating antimony from tin. The separation of antimony from arsenic and tin can be effected in the same manner, especially if only the determination of the antimony is required. If the arsenic and tin are also to be determined the former must first be separated by Fischer's method modified by Hufschmidt. Classen and Ludwig separate mercury quantitatively from a nitric solution by means of a current which yields in the voltameter 0·5 to 1 c.c. of detonating gas per minute. The action must be continued twelve to sixteen hours at the common temperature. In the same solution mercury may be separated from the alkaline earths, chromium, aluminium, nickel, cobalt, iron, manganese, uranium, and cadmium. To the aqueous solution of the metallic salts, about 200 c.c. in volume, are added 2 c.c. of strong nitric acid, and the separation is effected as above described. The deposit is then repeatedly washed with cold water (without interrupting the current) until the liquid no longer reacts acid; it is next repeatedly washed with absolute alcohol and dried for a short time over sulphuric acid in the exsiccator. Mercury cannot be separated from bismuth in this manner. For the electrolytic determination of bismuth S. Eliasberg (*Berichte*) mixes the bismuth salt weighed in a tared platinum capsule with 10 c.c. of a solution of potassium oxalate (1 : 3), heats, and adds gradually solid ammonium oxalate until complete solution is effected. He dilutes to 150 c.c., heats to 70° to 80°, and exposes the solution at this temperature to a current so weak that a development of gas is scarcely perceived in the voltameter. Very suitable are two Meidinger elements, a resistance of about 60 ohms being introduced into the circuit. When the bulk of the metal has been deposited, after about sixteen hours pure oxalic acid is added until the reaction is acid and the electrolysis is continued. After twenty-four hours a few drops of the solution are tested for bismuth with hydrogen sulphide. If it is absent the current is interrupted and the deposit is washed with water. The metal adheres so firmly that no loss is experienced in washing. The results are, however, often too high in consequence of a partial oxidation of the bismuth. Hence it is recommended to dissolve the metal in a little strong nitric acid, to evaporate the solution to dryness on the water-bath, converting the bismuth nitrate into oxide by ignition. In this manner bismuth may be separated from zinc, nickel, cobalt, and uranium, but not from iron. E. F. Smith and

E. B. Knerr have continued the experiments of H. Wiley Thomas and E. F. Smith on the electrolytic separation of bismuth and iron in a sulphuric solution (*Zeitschrift*, xxiii., 412). In this manner they effected the separation of bismuth from iron. By means of a current yielding 3 c.c. detonating gas per minute, they precipitated 0·1542 grm. bismuth in presence of 0·0230 grm. iron in three hours, the volume of liquid being 150 c.c. containing 3 c.c. of sulphuric acid. In the same manner they effected the separation of bismuth from aluminium, chromium, iron, cobalt, nickel, cadmium, manganese, uranium, and zinc.

Separation of the Primary from the Secondary and Tertiary Amines.—A. Michael.—The author utilises the property of the former, when heated with citraconic acid in aqueous solution, to give insoluble precipitates of anilide or analogous compounds. The secondary and tertiary amines form, under similar circumstances, no insoluble compounds.

Simultaneous Determination of Carbon, Hydrogen, and Nitrogen.—P. Jannasch and V. Meyer.—From *Liebig's Annalen*.

Determination of Carbon in Cellulose.—C. F. Cross and E. J. Bevan.—From the Chemical News.

Determination of Nitrogen present as Nitric Acid along with Organic Matter.—Max Jodlbauer.—The author has examined Asboth's modification of the Kjeldahl process, and finds the results uniformly below the truth. Instead of the benzoic acid proposed by Asboth he therefore uses an addition of phenol, and obtains thus concordant results.

Specific Gravity of Pure Alcohol and of its Admixtures with Water.—E. R. Squibb, E. H. Squibb, and C. F. Squibb.—From the Chemical News.

Determination of Tannin.—H. Dieudonné.—The author has taken up Hammer's method and determines the specific gravity of the solution before and after treatment with powdered hide by means of a special hydrometer, graduated in hundredth parts of a degree B. —(*Chemiker Zeitung*).

Blue Bread.—K. B. Lehmann.—Seeds of Rhinanthus and of Melampyrum, if ground up with grain, give a blue colour to bread. Rhinanthocyan, the pigment of the former, gives a spectrum very similar to that of indigo, which the pigment resembles also in being soluble in chloroform, though not in ether.

Coloured Sausage.—Otto Schweissinger.—No colour could be extracted either with ethylic or amylic alcohol. Red particles, approaching magenta in their shade, were discovered on microscopic examination.

Mineral Acids in Vinegar.—A. Foehring.—The author adds a fragment of hydrated zinc sulphide. In presence of mineral acids sulphuretted hydrogen is evolved.

Experimental Researches on Petroleum.—W. Thörne.—From the *Chemiker Zeitung*.

Qualitative Analysis of the Colours occurring in Commerce.—O. N. Witt.—The substance of this paper will be inserted at the earliest possible opportunity.

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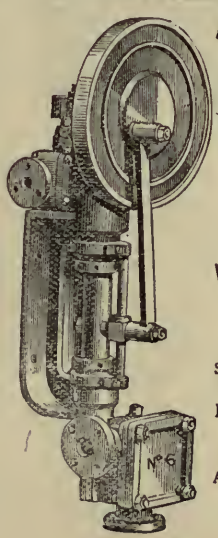

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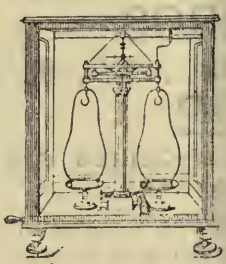

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THE CHEMICAL NEWS.

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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Manchester Meeting, September 1, 1887.

INAUGURAL ADDRESS OF THE PRESIDENT,

Sir Henry E. Roscoe, M.P., D.C.L., LL.D., Ph.D., F.R.S., V.P.C.S.

Manchester, distinguished as the birthplace of two of the greatest discoveries of modern science, heartily welcomes to-day, for the third time, the members and friends of the British Association for the Advancement of Science.

On the occasion of our first meeting in this city in the year 1842 the President, Lord Francis Egerton, commenced his address with a touching allusion to the veteran of science, John Dalton, the great chemist, the discoverer of the laws of chemical combination, the framer of the atomic theory upon which the modern science of chemistry may truly be said to be based. Lord Francis Egerton said:—"Manchester is still the residence of one whose name is uttered with respect wherever science is cultivated, who is here to-night to enjoy the honours, due to a long career of persevering devotion to knowledge, and to receive from myself, if he will condescend to do so, the expression of my own deep personal regret that increase of years, which to him up to this hour has been but increase of wisdom, should have rendered him in respect of mere bodily strength unable to fill on this occasion an office which in his case would have received more honour than it could confer. I do regret that any cause should have prevented the present meeting in his native town from being associated with the name"—and here I must ask you to allow me to exchange the name of Dalton in 1842 for that of Joule in 1887, and to add again in the words of the President of the former year that I would gladly have served as a doorkeeper in any house where Joule, the father of science in Manchester, was enjoying his just pre-eminence.

For it is indeed true that the mantle of John Dalton has fallen on the shoulders of one well worthy to wear it, one to whom science owes a debt of gratitude not less than that which it willingly pays to the memory of the originator of the atomic theory. James Prescott Joule it was who, in his determination of the mechanical equivalent of heat, about the very year of our first Manchester meeting, gave to the world of science the results of experiments which placed beyond reach of doubt or cavil the greatest and most far-reaching scientific principle of modern times, namely, that of the conservation of energy. This, to use the words of Tyndall, is indeed a generalisation of conspicuous grandeur fit to take rank with the principle of gravitation, more momentous, if that be possible, combining as it does the energies of the material universe into an organic whole, and enabling the eye of science to follow the flying shuttles of the universal power as it weaves what the Erdgeist in "Faust" calls "the living garment of God."

It is well, therefore, for us to remember, in the midst of the turmoil of our active industrial and commercial life, that Manchester not only well represents the energy of England in these practical directions, but that it possesses even higher claims to our regard and respect as being the seat of discoveries of which the value, not only to pure science, is momentous, but which also lie at the foundation of all our material progress and all our industrial success. For without a knowledge of the laws of chemical combination all the marvellous results with which modern industrial chemistry has astonished the world could not have been achieved, whilst the knowledge of the quantitative relations existing between the several forms of energy, and the possibility of expressing their amount in terms of ordinary mechanics, are matters which now constitute the life-breath of every branch of applied science. For example, before Dalton's discovery every manufacturer of oil of vitriol—a substance now made each week in thousands of tons within a few miles of this spot—every manufacturer had his own notions of the quantity of sulphur which he ought to burn in order to make a certain weight of sulphuric acid, but he had no idea that only a given weight of sulphur can unite with a certain quantity of oxygen and of water to form the acid, and that an excess of any one of the component parts was not only useless but harmful. Thus, and in tens of thousands of other instances, Dalton replaced rule of thumb by scientific principle. In like manner the applications of Joule's determination of the mechanical equivalent of heat are even more general; the increase and measurement of the efficiency of our steam engines and the power of our dynamos are only two of the numerous examples which might be adduced of the practical value of Joule's work.

If the place calls up these thoughts, the time of our meeting also awakens memories of no less interest, in the recollection that we this year celebrate the Jubilee of her Most Gracious Majesty's accession to the throne. It is right that the members of the British Association for the Advancement of Science should do so with heart and voice, for although science requires and demands no royal patronage, we thereby express the feeling which must be uppermost in the hearts of all men of science, the feeling of thankfulness that we have lived in an age which has witnessed an advance in our knowledge of nature, and a consequent improvement in the physical, and let us trust also in the moral and intellectual, well being of the people hitherto unknown; an age with which the name of Victoria will ever be associated.

To give even a sketch of this progress, to trace even in the merest outline the salient points of the general history of science during the fifty momentous years of her Majesty's reign, is a task far beyond my limited powers. It must suffice for me to point out to you, to the best of my ability, some few of the steps of that progress as evidenced in the one branch of science with which I am most familiar, and with which I am more closely concerned, the science of chemistry.

In the year 1837 chemistry was a very different science from that existing at the present moment. Priestley, it is true, had discovered oxygen, Lavoisier had placed the phenomena of combustion on their true basis, Davy had decomposed the alkalis, Faraday had liquefied many of the gases, Dalton had enunciated the laws of chemical combination by weight, and Gay-Lussac had pointed out the fact that a simple volumetric relation governs the combination of the gases. But we then possessed no knowledge of chemical dynamics, we were then altogether unable to explain the meaning of the heat given off in the act of chemical combination. The atomic theory was indeed accepted, but we were as ignorant of the mode of action of the atoms and as incapable of explaining their mutual relationship as were the ancient Greek philosophers. Fifty years ago, too, the connection existing between the laws of life, vegetable and animal, and the phenomena of inorganic chemistry, was ill understood. The idea that the functions of living beings are controlled by the same forces, chemical and physical, which regulate the changes occurring in the inanimate world, was then one held by only a very few of the foremost thinkers of the time. Vital force was a term in every-

one's mouth, an expression useful, as Goethe says, to disguise our ignorance, for—

Wo die Begriffe fehlen,
Da tritt ein Wort zur rechten Zeit sich ein.

Indeed the pioneer of the chemistry of life, Liebig himself, cannot quite shake himself free from the bonds of orthodox opinion, and he who first placed the phenomena of life on a true basis cannot trust his chemical principles to conduct the affairs of the body, but makes an appeal to vital force to help him out of his difficulties; as when in the body politic an unruly mob requires the presence and action of physical force to restrain it and to bring its members under the saving influence of law and order, so too, according to Liebig's views, in the body coporeal a continual conflict between the chemical forces and the vital power occurs throughout life, in which the latter, when it prevails, insures health and a continuance of life, but of which defeat insures disease or death. The picture presented to the student of to-day is a very different one. We now believe that no such conflict is possible, but that life is governed by chemical and physical forces, even though we cannot in every case explain its phenomena in terms of these forces; that whether these tend to continue or to end existence depends upon their nature and amount, and that disease and death are as much a consequence of the operation of chemical and physical laws as are health and life.

Looking back again to our point of departure fifty years ago, let us for a moment glance at Dalton's labours, and compare his views and those of his contemporaries with the ideas which now prevail. In the first place it is well to remember that the keystone of his atomic theory lies not so much in the idea of the existence and the indivisible nature of the particles of matter—though this idea was so firmly implanted in his mind that, being questioned on one occasion on the subject, he said to his friend the late Mr. Ransome, "Thou knowst it must be so, for no man can split an atom"—as in the assumption that the weights of these particles are different. Thus, whilst each of the ultimate particles of oxygen has the same weight as every other particle of oxygen, and each atom of hydrogen, for example, has the same weight as every other particle of hydrogen, the oxygen atom is sixteen times heavier than that of hydrogen, and so on for the atoms of every chemical element, each having its own special weight. It was this discovery of Dalton, together with the further one that the elements combine in the proportions indicated by the relative weights of their atoms or in multiples of these proportions, which at once changed chemistry from a qualitative to a quantitative science, making the old invocation prophetic, "Thou hast ordered all things in measure and number and weight."

The researches of chemists and physicists during the last fifty years have not only strengthened but broadened the foundations of the great Manchester philosopher's discoveries. It is true that his original numbers, obtained by crude and inaccurate methods, have been replaced by more exact figures, but his laws of combination and his atomic explanation of those laws stand as the great bulwarks of our science.

On the present occasion it is interesting to remember that within a stone's-throw of this place is the small room belonging to our Literary and Philosophical Society which served Dalton as his laboratory. Here with the simplest of all possible apparatus—a few cups, penny ink bottles, rough balances, and self-made thermometers and barometers—Dalton accomplished his great results. Here he patiently worked, marshalling facts to support his great theory, for as an explanation of his laborious experimental investigations the wise old man says:—"Having been in my progress so often misled, by taking for granted the results of others, I have determined to write as little as possible but what I can attest by my own experience." Nor ought we when here assembled to forget that the last three of Dalton's experimental essays—one of which, on a new method of measuring water of crystallisation, contained more than the germ of a great discovery—were communicated to our Chemical Section in 1842, and that this was the last memorable act of his scientific life. In this last of his contributions to science, as in his first, his method of procedure was that which has been marked out as the most fruitful by almost all the great searchers after nature's secrets, namely the assumption of a certain view as a working hypothesis, and the subsequent institution of experiment to bring this hypothesis to a test of reality upon which a legitimate theory is afterwards to be based. "Dalton," as Henry well says, "valued detailed facts mainly, if not solely, as the stepping-stones to comprehensive generalisations."

Next let us ask what light the research of the last fifty years has thrown on the subject of the Daltonian atoms: first, as regards their size; secondly, in respect to their indivisibility and mutual relationships; and thirdly, as regards their motions.

As regards the size and shape of the atoms, Dalton offered no opinion, for he had no experimental grounds on which to form it, believing that they were inconceivably small and altogether beyond the grasp of our senses aided by the most powerful appliances of art. He was in the habit of representing his atoms and their combinations diagrammatically as round discs or spheres made of wood, by means of which he was fond of illustrating his theory. But such mechanical illustrations are not without their danger, for I well remember the answer given by a pupil to a question on the atomic theory: "Atoms are round balls of wood invented by Dr. Dalton." So determinedly indeed did he adhere to his mechanical method of representing the chemical atoms and their combinations that he could not be prevailed upon to adopt the system of chemical formulæ introduced by Berzelius and now universally employed. In a letter addressed to Graham in April, 1837, he writes: "Berzelius's symbols are horrifying. A young student in chemistry might as soon learn Hebrew as make himself acquainted with them." And again: "They appear to me equally to perplex the adepts in science, to discourage the learner, as well as to cloud the beauty and simplicity of the atomic theory."

But modern research has accomplished, as regards the size of the atom, at any rate to a certain extent, what Dalton regarded as impossible. Thus in 1865 Loschmidt, of Vienna, by a train of reasoning which I cannot now stop to explain, came to the conclusion that the diameter of an atom of oxygen or nitrogen was 1-10,000,000th of a centimetre. With the highest known magnifying power we can distinguish the 1-40,000th part of a centimetre; if now we imagine a cubic box each of whose sides has the above length, such a box when filled with air will contain from 60 to 100 millions of atoms of oxygen and nitrogen. A few years later William Thomson extended the methods of atomic measurement, and came to the conclusion that the distance between the centres of contiguous molecules is less than 1-5,000,000th and greater than 1-1,000,000,000th of a centimetre; or, to put it in language more suited to the ordinary mind, Thomson asks us to imagine a drop of water magnified up to the size of the earth, and then tells us that the coarseness of the graining of such a mass would be something between a heap of small shot and a heap of cricket balls. Or again, to take Clifford's illustration, you know that our best microscopes magnify from 6000 to 8000 times; a microscope which would magnify that result as much again would show the molecular structure of water. Or again, to put it in another form, if we suppose that the minutest organism we can now see were provided with equally powerful microscopes, these beings would be able to see the atoms.

Next, as to the indivisibility of the atom, involving also the question as to the relationships between the atomic weights and properties of the several elementary bodies.

Taking Dalton's aphorism, "Thou knowst no man can split an atom," as expressing the view of the enunciator

of the atomic theory, let us see how far this idea is borne out by subsequent work. In the first place, Thomas Thomson, the first exponent of Dalton's generalisation, was torn by conflicting beliefs until he found peace in the hypothesis of Prout, that the atomic weights of all the so-called elements are multiples of a common unit, which doctrine he sought to establish, as Thorpe remarks, by some of the very worst quantitative determinations to be found in chemical literature, though here I may add that they were not so incorrect as Dalton's original numbers.

Coming down to a somewhat later date, Graham, whose life was devoted to finding what the motion of an atom was, freed himself from the bondage of the Daltonian aphorism, and defined the atom not as a thing which cannot be divided, but as one which has not been divided. With him, as with Lucretius, as Angus Smith remarks, the original atom may be far down.

But speculative ideas respecting the constitution of matter have been the scientific relaxation of many minds from olden time to the present. In the mind of the early Greek the action of the atom as one substance taking various forms by unlimited combinations was sufficient to account for all the phenomena of the world. And Dalton himself, though upholding the indivisibility of his ultimate particles, says :—"We do not know that any of the bodies denominated elementary are absolutely indecomposable." Again Boyle, treating of the origin of form and quality, says :—"There is one universal matter common to all bodies—an extended divisible and impenetrable substance." Then Graham in another place expresses a similar thought when he writes : "It is conceivable that the various kinds of matter now recognised as different elementary substances may possess one and the same ultimate or atomic molecules existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of gravity upon all bodies."

What experimental evidence is now before us bearing upon these interesting speculations? In the first place, then, the space of fifty years has completely changed the face of the inquiry. Not only has the number of distinct well-established elementary bodies increased from fifty-three in 1837 to seventy in 1887 (not including the *twenty* or more new elements recently said to have been discovered by Krüss and Nilson in certain rare Scandinavian minerals), but the properties of these elements have been studied, and are now known to us with a degree of precision then undreamt of. So that relationships existing between these bodies which fifty years ago were undiscernible are now clearly manifest, and it is to these relationships that I would for a moment ask your attention. I have already stated that Dalton measured the relative weights of the ultimate particles by assuming hydrogen as the unit, and that Prout believed that on this basis the atomic weights of all the other elements would be found to be multiples of the atomic weight of hydrogen, thus indicating that an intimate constitutional relation exists between hydrogen and all the other elements.

Since the days of Dalton and Prout the truth or otherwise of Prout's law has been keenly contested by the most eminent chemists of all countries. The inquiry is a purely experimental one, and only those who have a special knowledge of the difficulties which surround such inquiries can form an idea of the amount of labour and self-sacrifice borne by such men as Dumas, Stas, and Marignac in carrying out delicate researches on the atomic weights of the elements. What is, then, the result of these most laborious experiments? It is that, whilst the atomic weights of the elements are not exactly either multiples of the unit or of half the unit, many of the numbers expressing most accurately the weight of the atom approximate so closely to a multiple of that of hydrogen that we are constrained to admit that these approximations cannot be a mere matter of chance, but that some reason must exist for them. What that reason is, and why a close approximation and yet something short of absolute identity exists, is as yet hidden behind the veil; but who is there that doubts that when this Association celebrates its centenary this veil will have been lifted and this occult but fundamental question of atomic philosophy shall have been brought into the clear light of day?

But these are by no means all the relationships which modern science has discovered with respect to the atoms of our chemical elements. So long ago as 1829 Döbereiner pointed out that certain groups of elements exist presenting in all their properties strongly marked family characteristics, and this was afterwards extended and insisted upon by Dumas. We find, for example, in the well-known group of chlorine, bromine, and iodine, these resemblances well developed, accompanied moreover by a proportional graduation in their chemical and physical properties. Thus, to take the most important of all their characters, the atomic weight of the middle term is the mean of the atomic weights of the two extremes. But these groups of triads appeared to be unconnected in any way with one another, nor did they seem to bear any relation to the far larger number of the elements not exhibiting these peculiarities.

Things remained in this condition until 1863, when Newlands threw fresh light upon the subject, showing a far-reaching series of relationships. For the first time we thus obtained a glance into the mode in which the elements are connected together, but, like so many new discoveries, this did not meet with the recognition which we now see it deserves. But whilst England thus had the honour of first opening up this new path, it is to Germany and to Russia that we must look for the consummation of the idea. Germany, in the person of Lothar Meyer, keeps, as it is wont to do, strictly within the limits of known facts. Russia, in the person of Mendelejeff, being of a somewhat more imaginative nature, not only seizes the facts which are proved, but ventures upon prophecy. These chemists, amongst whom Carnelley must be named, agree in placing all the elementary bodies in a certain regular sequence, thus bringing to light a periodic recurrence of analogous chemical and physical properties, on account of which the arrangement is termed the periodic system of the elements.

In order to endeavour to render this somewhat complicated matter clear to you, I may perhaps be allowed to employ a simile. Let us, if you please, imagine a series of human families, a French one, represented by Dumas, an English one, by name Newlands, a German one, the family of Lothar Meyer, and lastly a Russian one, that of Mendelejeff. Let us next imagine the names of these chemists placed in a horizontal line in the order I have mentioned. Then let us write under each the name of his father, and again, in the next lower line, that of his grandfather, followed by that of his great-grandfather, and so on. Let us next write against each of these names the names the number of years which has elapsed since the birth of the individual. We shall then find that these numbers regularly increase by a definite amount, *i.e.*, by the average age of a generation, which will be approximately the same in all the four families. Comparing the ages of the chemists themselves we shall observe certain differences, but these are small in comparison with the period which has elapsed since the birth of any of their ancestors. Now each individual in this series of family trees represents a chemical element; and just as each family is distinguished by certain idiosyncrasies, so each group of the elementary bodies thus arranged shows distinct signs of consanguinity.

But more than this, it not unfrequently happens that the history and peculiarities of some member of a family may have been lost, even if the memory of a more remote and more famous ancestor may be preserved, although it is clear that such an individual must have had an existence. In such a case Francis Galton would not hesitate from the characteristics of the other members to reproduce the physical and even the mental peculiarities of the missing

member; and should genealogical research bring to light the true personal appearance and mental qualities of the man, these would be found to coincide with Galton's estimate.

Such predictions and such verifications have been made in the case of no less than three of our chemical elements.

Thus, Mendelejeff pointed out that if, in the future, certain lacunæ in his table were to be filled, they must be filled by elements possessing chemical and physical properties which he accurately specified. Since that time these gaps have actually been stopped by the discovery of gallium by Lecoq de Boisbaudran, of scandium by Nilson, and of Germanium by Winkler, and their properties, both physical and chemical, as determined by their discoverers, agree absolutely with those predicted by the Russian chemist. Nay, more than this, we not unfrequently have had to deal with chemical foundlings, elements whose parentage is quite unknown to us. A careful examination of the personality of such waifs has enabled us to restore them to the family from which they have been separated by un unkind fate, and to give them that position in chemical society to which they are entitled.

These remarkable results, though they by no means furnish a proof of the supposition already referred to, viz., that the elements are derived from a common source, clearly point in this direction, and lend some degree of colour to the speculations of those whose scientific imagination, wearying of dry facts, revels in picturing to itself an elemental Bathybius, and in applying to the inanimate, laws of evolution similar to those which rule the animate world. Nor is there wanting other evidence regarding this inquiry, for here heat, the great analyser, is brought into court. The main portion of the evidence consists in the fact that distinct chemical individuals capable of existence at low temperatures are incapable of existence at high ones, but split up into new materials possessing a less complicated structure than the original. And here it may be well to emphasize the distinction which the chemist draws between the atom and the molecule, the latter being a more or less complicated aggregation of atoms, and especially to point out the fundamental difference between the question of separating the atoms in the molecule and that of splitting up the atom itself. The decompositions above referred to are, in fact, not confined to compound bodies, for Victor Meyer has proved, in the case of iodine that the molecule at high temperatures is broken to atoms, and J. J. Thomson has added to our knowledge by showing that this breaking up of the molecule may be effected not only by heat vibrations, but likewise by the electrical discharge at a comparatively low temperature.

How far, now, has this process of simplification been carried? Have the atoms of our present elements been made to yield? To this a negative answer must undoubtedly be given, for even the highest of terrestrial temperatures, that of the electric spark, has failed to shake any one of these atoms in two. That this is the case has been shown by the results with which spectrum analysis, that new and fascinating branch of science, has enriched our knowledge, for that spectrum analysis does give us most valuable aid in determining the varying molecular conditions of matter is admitted by all. Let us see how this bears on the question of the decomposition of the elements, and let us suppose for a moment that certain of our present elements, instead of being distinct substances, were made up of common ingredients, and that these compound elements, if I may be allowed to use so incongruous a term, are split up at the temperature of the electric spark into less complicated molecules. Then the spectroscopic examination of such a body must indicate the existence of these common ingredients by the appearance in the spark spectra of these elements of identical bright lines. Coincidences of this kind have indeed been observed, but on careful examination these have been shown to be due either to the presence of some one of the other elements as an impurity or to insufficient observational power. This absence of coincident lines admits, however, of two explanations—either that the elements are not decomposed at the temperature of the electric spark, or, what appears to me a much more improbabie supposition, each one of the numbers of bright lines exhibited by every element indicates the existence of a separate constituent, no two of this enormous number being identical.

Terrestrial analysis having thus failed to furnish favourable evidence, we are compelled to see if any information is forthcoming from the chemistry of the sun and stars. And here I would remark that it is not my purpose now to dilate on the wonders which this branch of modern science has revealed. It is sufficient to remind you that chemists thus have the means placed at their disposal of ascertaining with certainty the presence of elements well known on this earth in fixed stars so far distant that we are now receiving the light which emanated from them perhaps even thousands of years ago.

Since Bunsen and Kirchhoff's original discovery in 1859, the labours of many men of science of all countries have largely increase our knowledge of the chemical constitution of the sun and stars, and to no one does science owe more in this direction than to Lockyer and Huggins in this country, and to Young in the New England beyond the seas. Lockyer has of late years devoted his attention chiefly to the varying nature of the bright lines seen under different conditions of time and place on the solar surface, and from these observations he has drawn the inference that the matching observed by Kirchhoff between, for instance, the iron lines as seen in our laboratories and those visible in the sun, has fallen to the ground. He further explains this want of uniformity by the fact that at the higher transcendental temperatures of the sun the substance which we know here as iron is resolved into separate components. Other experimentalists, however, while accepting Lockyer's facts as to the variations in the solar spectrum, do not admit his conclusions, and would rather explain the phenomena by the well-known differences which occur in the spectra of all the elements when their molecules are subject to change of temperature or change of position.

Further, arguments in favour of this idea of the evolution of the elements have been adduced from the phenomena presented by the spectra of the fixed stars. It is well known that some of these shine with a white, others with a red, and others again with a blue light; and the spectroscope, especially under the hands of Huggins, has shown that the chemical constitution of these stars is different. The white stars, of which Sirius may be taken as a type, exhibit a much less complicated spectrum than the orange and the red stars; the spectra of the latter remind us more of those of the metalloids and of chemical compounds than of the metals. Hence it has been argued that in the white, presumably the hottest, stars a celestial dissociation of our terrestrial elements may have taken place, whilst in the cooler stars, probably the red, combination even may occur. But even in the white stars we have no *direct* evidence that a decomposition of any terrestrial atom has taken place; indeed we learn that the hydrogen atom, as we know it here, can endure unscathed the inconceivably fierce temperature of stars presumably many times more fervid than our sun, as Sirius and Vega.

Taking all these matters into consideration, we need not be surprised if the earthbound chemist should, in the absence of celestial evidence which is incontestable, continue, for the present at least, and until fresh evidence is forthcoming, to regard the elements as the unalterable foundation stones upon which his science is based.

Pursuing another line of inquiry on this subject, Crookes has added a remarkable contribution to the question of the possibility of decomposing the elements. With his well-known experimental prowess, he has discovered a new and beautiful series of phenomena, and has shown

that the phosphorescent lights emitted by certain chemical compounds, especially the rare earths, under an electric discharge in a high vacuum exhibit peculiar and characteristic lines. For the purpose of obtaining his material Crookes started from a substance believed by chemists to be homogeneous, such, for example, as the rare earth yttria, and succeeded by a long series of fractional precipitations in obtaining products which yield different phosphorescent spectra, although when tested by the ordinary methods of what we may term high temperature spectroscopy, they appear to be the one substance employed at the starting point. The other touchstone by which the identity, or otherwise, of these various products might be ascertained, viz., the determination of their atomic weights, has not, as yet, engaged Crookes's attention. In explanation of these singular phenomena, the discoverer suggests two possibilities. First, that the bodies yielding the different phosphorescent spectra are different elementary constituents of the substance which we call yttria. Or, if this be objected to because they all yield the same spark spectrum, he adopts the very reasonable view that the Daltonian atom is probably, as we have seen, a system of chemical complexity; and adds to this the idea that these complex atoms are not all of exactly the same constitution and weight, the differences, however, being so slight that their detection has hitherto eluded our most delicate tests, with the exception of this one of phosphorescence in a vacuum. To these two explanations, Marignac, in a discussion of Crookes's results, adds a third. It having been shown by Crookes himself that the presence of the minutest traces of foreign bodies produce remarkable alterations in the phosphorescent spectra, Marignac suggests that in the course of the thousands of separations which must be made before these differences become manifest, traces of foreign bodies may have been accidentally introduced, or, being present in the original material, may have accumulated to a different extent in the various fractions, their presence being indicated by the only test by which they can now be detected. Which of these three explanations is the true one must be left to future experiment to decide.

We must now pass from the statics to the dynamics of chemistry; that is, from the consideration of the atoms at rest to that of the atoms in motion. Here again we are indebted to John Dalton for the first step in this direction, for he showed that the particles of a gas are constantly flying about in all directions; that is, that gases diffuse into one another as an escape of coal gas from a burner, for example, soon makes itself perceptible throughout the room. Dalton, whose mind was constantly engaged in studying the molecular condition of gases, first showed that a light gas cannot rest upon a heavier gas as oil upon water, but that an interpenetration of each gas by the other takes place. It is, however, to Graham's experiments, made rather more than half a century ago, that we are indebted for the discovery of the law regulating these molecular motions of gases, proving that their relative rates of diffusion are inversely proportional to the square roots of their densities, so that oxygen being 16 times heavier than hydrogen, their relative rates of diffusion are 1 and 4.

But whilst Dalton and Graham indicated that the atoms are in a continual state of motion, it is to Joule that we owe the first accurate determination of the rate of that motion. At the Swansea Meeting in 1848, Joule read a paper before Section A on the Mechanical Equivalent of Heat on the Constitution of Elastic Fluids. In this paper Joule remarks whether we conceive the particles to be revolving round one another according to the hypothesis of Davy, or flying about in every direction according to Herapath's view, the pressure of the gas will be in proportion to the *vis viva* of its particles. "Thus it may be shown that the particles of hydrogen at the barometrical pressure of 30 inches at a temperature of 60° must move with a velocity of 6225·54 feet per second in order to produce a pressure of 14·714 lbs. on the square inch;" or, to put it in other words, a molecular cannonade or hailstorm of particles, at the above rate—a rate, we must remember, far exceeding that of a cannon ball—is maintained against the bounding surface.

We can, however, go a step further and calculate with Clerk Maxwell the number of times in which this hydrogen molecule, moving at the rate of 70 miles per minute, strikes against others of the vibrating swarm, and we learn that in one second of time it must knock against others no less than 18 thousand million times.

And here we may pause and dwell for a moment on the reflection that in nature there is no such thing as great or small, and that the structure of the smallest particle, invisible even to our most searching vision, may be as complicated as that of any one of the heavenly bodies which circle round our sun.

But how does this wonderful atomic motion affect our chemistry? Can chemical science or chemical phenomena throw light upon this motion, or can this motion explain any of the known phenomena of our science? I have already said that Lavoisier left untouched the dynamics of combustion. He could not explain why a fixed and unalterable amount of heat is in most cases emitted but in some cases absorbed when chemical combination takes place. What Lavoisier left unexplained Joule has made clear. On August 25, 1843, Joule read a short communication, I am glad to remember, before the Chemical Section of our Association, meeting that year at Cork, containing an announcement of a discovery which was to revolutionise modern science. This consisted in the determination of the mechanical equivalent of heat, in proving by accurate experiment that the expenditure of energy equal to that developed by the weight of 772 pounds falling through one foot at Manchester, the temperature of one pound of water can be raised 1° Fahrenheit. In other words, every change in the arrangement of the particles is accompanied by a definite evolution or an absorption of heat. In all such cases the molecular energy leaves the potential to assume the kinetic form, or *vice versâ*. Heat is evolved by the clashing of the atoms, and this amount is fixed and definite.

Thus it is to Joule we owe the foundation of chemical dynamics and the basis of thermal chemistry. As the conservation of mass or the principle of the indestructibility of matter forms the basis of chemical statics, so the principle of the conservation of energy* constitutes the foundation of chemical dynamics. Change in the form of matter and change in the form of energy are the universal accompaniments of every chemical operation. Here again it is to Joule we owe the proof of the truth of this principle in another direction, viz., that when electrical energy is developed by chemical change a corresponding quantity of chemical energy disappears. Energy is defined by Maxwell as the power of doing work, and work is the act of producing a change of configuration in a system in opposition to a force which resists that change. Chemical action produces such a change of configuration in the molecules. Hence, as Maxwell says, "a complete knowledge of the mode in which the potential energy of a system varies with the configuration would enable us to predict every possible motion of the system under the action of given external forces, provided we were able to overcome the purely mathematical difficulties of the calculation." The object of thermal chemistry is to measure these changes of energy by thermal methods, and to connect these with chemical changes, to estimate the attractions of the atoms and molecules to which the name of chemical affinity has been applied, and thus to solve the most fundamental problem of chemical science. How far has modern research approached the solution of this most difficult problem? How far can we answer the

* "The t energy of any material system is a quantity which can neither be increased nor diminished by any action between the parts of the system, though it may be transformed into any of the forms of which energy is susceptible."—Maxwell.

question, what is the amount of the forces at work in these chemical changes? What laws govern these forces? Well, even in spite of the results with which recent researches, especially the remarkable ones of the Danish philosopher Thomsen have enriched us, we must acknowledge that we are yet scarcely in sight of Maxwell's position of successful prediction. Thermal chemistry, we must acknowledge, is even yet in its infancy; it is, however, an infant of sturdy growth, likely to do good work in the world, and to be a credit to him who is its acknowledged father, as well as to those who have so carefully tended it in its early years.

But recent investigation in another direction bids fair even to eclipse the results which have been obtained by the examination of thermal phenomena. And this lies in the region of electrical chemistry. Faraday's work relating to conductivity of chemical substances has been already referred to, and this has been since substantiated and extended to pure substances by Kohlrausch. It has been shown, for example, that the resistance of absolutely pure water is almost an infinite quantity. But a small quantity of an acid, such as acetic or butyric acid, greatly increases the conductivity; but more than this, it is possible by determination of the conductivity of a mixture of water with these two acids to arrive at a conclusion as to the partition of the molecules of the water between the acids. Such a partition, however, implies a change of position, and therefore we are furnished with a means of recognising the motion of the molecules in a liquid, and of determining its amount. Thus it has been found that the hindrance to molecular motion is more affected by the chemical character of the liquid than by physical characters such as viscosity. We have seen that chemical change is always accompanied by molecular motion, and further evidence of the truth of this is gained from the extraordinary chemical inactivity of pure unmixed substances. Thus pure anhydrous hydrochloric acid does not act upon lime, whereas the addition of even a trace of moisture sets up a most active chemical change, and hundreds of other examples of a similar kind might be stated. Bearing in mind that these pure anhydrous compounds do not conduct, we are led to the conclusion that an intimate relation exists between chemical activity and conductivity. And we need not stop here; for a method is indicated indeed by which it will be possible to arrive at a measure of chemical affinity from determination of conductivity. It has indeed been already shown that the rate of change in the saponification of acetic ether, is directly proportional to the conductivity of the liquid employed.

Such wide-reaching inquiries into new and and fertile fields, in which we seem to come into nearer touch with the molecular state of matter, and within a measurable distance of accurate mathematical expression, leads to confident hope that Lord Rayleigh's pregnant words at Montreal may ere long be realised: "It is from the further study of electrolysis that we may expect to gain improved views as to the nature of chemical reactions, and of the forces concerned in bringing them about; and I cannot help thinking that the next great advance, of which we already have some foreshadowing, will come on this side."

There is, perhaps, no branch of our science in which the doctrine of the Daltonian atom plays a more conspicuous part than in organic chemistry or the chemistry of the carbon compounds, as there is certainly none in which such wonderful progress has been made during the last fifty years. One of the most striking and perplexing discoveries made rather more than half a century ago was that chemical compounds could exist which, whilst possessing an identical chemical composition,—that is, containing the same percentage quantity of their constituents,—are essentially distinct chemical substances exhibiting different properties. Dalton was the first to point out the existence of such substances, and to suggest that the difference was to be ascribed to a different or to a multiple arrangement of the constituent atoms. Faraday soon afterwards proved that this supposition was correct, and the research of Liebig and Wöhler on the identity of composition of the salts of fulminic and cyanic acid gave further confirmation to the conclusion, leading Faraday to remark that "now we are taught to look for bodies composed of the same elements in the same proportion but differing in their qualities, they may probably multiply upon us." How true this prophecy has become we may gather from the fact that we now know of thousands of cases of this kind, and that we are able not only to explain the reason of their difference by virtue of the varying position of the atoms within the molecule, but even to predict the number of distinct variations in which any given chemical compound can possibly exist. How large this number may become may be understood from the fact that, for example, one chemical compound, a hydrocarbon containing thirteen atoms of carbon combined with twenty-eight atoms of hydrogen, can be shown to be capable of existing in no less than 802 distinct forms.

Experiment in every case in which it has been applied has proved the truth of such a prediction, so that the chemist has no need to apply the cogent arguments sometimes said to be used by experimentalists enamoured of pet theories, "When facts do not agree with theory, so much the worse for the facts!" This power of successful prediction constitutes a high-water mark in science, for it indicates that the theory upon which such a power is based is a true one.

But if the Daltonian atom forms the foundation of this theory, it is upon a knowledge of the mode of arrangement of these atoms and on a recognition of their distinctive properties that the superstructure of modern organic chemistry rests. Certainly it does appear almost to verge on the miraculous that chemists should now be able to ascertain with certainty the relative position of atoms in a molecule so minute that millions upon millions, like the angels in the schoolmen's discussion, can stand on a needle's point. And yet this process of orientation is one which is accomplished every day in our laboratories, and one which more than any other has led to results of a startling character. Still, this sword to open the oyster of science would have been wanting to us if we had not taken a step farther than Dalton did, in the recognition of the distinctive nature of the elemental atoms. We now assume on good grounds that the atom of each element possesses distinct capabilities of combination; some a single capability, others a double, others a triple, and others again a fourfold combining capacity. The germs of this theory of valency, one of the most fruitful of modern chemical ideas, were enunciated by Frankland in 1852, but the definite explanation of the linking of atoms, of the tetrad nature of the carbon atoms, their power of combination, and of the difference in structure between the fatty and aromatic series of compounds, was first pointed out by Kekulé in 1857; though we must not forget that this great principle was foreshadowed so long ago as 1833 from a physical point of view by Faraday in his well-known laws of electrolysis, and that it is to Helmholtz in his celebrated Faraday lecture that we owe the complete elucidation of the subject; for, whilst Faraday has shown that the number of the atoms electrolytically deposited is in the inverse ratio of their valencies, Helmholtz has explained this by the fact that the quantity of electricity with which each atom is associated is directly proportional to its valency.

Amongst the tetrad class of elements, carbon, the distinctive element of organic compounds, finds its place; and the remarkable fact that the number of carbon compounds far exceeds that of all the other elements put together receives its explanation. For these carbon atoms not only possess four means of grasping other atoms, but these four-handed carbon atoms have a strong partiality for each other's company, and readily attach themselves hand in hand to form open chains or closed

rings to which the atoms of other elements join to grasp the unoccupied carbon hand, and thus to yield a dancing company in which all hands are locked together. Such a group, each individual occupying a given position with reference to the others, constitutes the organic molecule. When, in such a company, the individual members change hands, a new combination is formed. And as in such an assembly the eye can follow the changing positions of the individual members, so the chemist can recognise in his molecule the position of the several atoms, and explain by this the fact that each arrangement constitutes a new chemical compound possessing different properties, and account in this way for the decompositions which each differently constituted molecule is found to undergo.

Chemists are, however, not content with representing the arrangement of the atoms in one plane, as on a sheet of paper, but attempt to express the position of the atoms in space. In this way it is possible to explain certain observed differences in isomeric bodies which otherwise baffled our efforts. To Van t'Hoff, in the first instance, and more recently to Wislicenus, chemistry is indebted for work in this direction, which throws light on hitherto obscure phenomena, and points the way to still further and more important advances.

It is this knowledge of the mode in which the atoms in the molecule are arranged, this power of determining the nature of this arrangement, which has given to organic chemistry the impetus which has overcome so many experimental obstacles, and given rise to such unlooked-for results. Organic chemistry has now become synthetic. In 1837 we were able to build up but very few and very simple organic compounds from their elements; indeed the views of chemists were much divided as to the possibility of such a thing. Both Gmelin and Berzelius argued that organic compounds, unlike inorganic bodies, cannot be built up from their elements. Organic compounds were generally believed to be special products of the so-called vital force, and it was only intuitive minds, like those of Liebig and Wöhler, who foresaw what was coming, and wrote in 1837 strongly against this view, asserting that the artificial production in our laboratories of all organic substances, so far as they do not constitute a living organism, is not only probable but certain. Indeed they went a step further, and predicted that sugar, morphia, salicine, will all thus be prepared,—a prophecy which, I need scarcely remind you, has been after fifty years fulfilled, for at the present time we can prepare an artificial sweetening principle, an artificial alkaloid, and salicine.

In spite of these predictions, and in spite of Wöhler's memorable discovery in 1828 of the artificial production of urea, which did in reality break down for ever the barrier of essential chemical difference between the products of the inanimate and of the animate world, still, even up to a much later date, contrary opinions were held, and the synthesis of urea was looked upon as the exception which proves the rule. So it came to pass that for many years the artificial production of any of the more complicated organic substances was believed to be impossible. Now the belief in a special vital force has disappeared like the *ignis-fatuus*, and no longer lures us in the wrong direction. We know now that the same laws regulate the formation of chemical compounds in both animate and inanimate nature, and the chemist only asks for a knowledge of the constitution of any definite chemical compound found in the organic world in order to be able to promise to prepare it artificially.

But the progress of synthetic organic chemistry, which has of late been so rapid, was made in the early days of the half-century only by feeble steps and slow. Seventeen long years elapsed between Wöhler's discovery and the next real synthesis. This was accomplished by Kolbe, who in 1845 prepared acetic acid from its elements. But then a splendid harvest of results gathered in by chemists of all nations quickly followed, a harvest so rich and so varied that we are apt to be overpowered by its wealth, and amidst so much that is alluring and striking we may well find it difficult to choose the most appropriate examples for illustrating the power and the extent of modern chemical synthesis.

Next, as a contrast to our picture, let us for a moment glance back again to the state of things fifty years ago, and then notice the chief steps by which we have arrived at our present position. In 1837 organic chemistry possessed no scientific basis, and therefore no classification of a character worthy of the name. Writing to Berzelius in that year, Wöhler describes the condition of organic chemistry as one enough to drive a man mad. "It seems to me," says he "like the tropical forest primæval, full of the strangest growths, an endless and pathless thicket in which a man may well dread to wander." Still clearances had already been made in this wilderness of facts. Berzelius in 1832 welcomed the results of Liebig and Wöhler's research on benzoic acid as the dawn of a new era; and such it really was, inasmuch as it introduced a novel and fruitful idea, namely, the possibility of a group of atoms acting like an element by pointing out the existence of organic radicals. This theory was strengthened and confirmed by Bunsen's classical researches on the cacodyl compounds, in which he showed that a common group of elements which acts exactly as a metal can exist in the free state, and this was followed soon afterwards by isolation of the so-called alcohol radicals by Frankland and Kolbe. It is, however, to Schorlemmer that we owe our knowledge of the true constitution of these bodies, a matter which proved to be of vital importance for the further development of the science.

Turning our glance in another direction we find that Dumas, in 1834, by his law of substitution threw light upon a whole series of singular and unexplained phenomena, by showing that an exchange can take place between the constituent atoms in a molecule. Laurent indeed went farther, and assumed that a chlorine atom, for example, took up the position vacated by an atom of hydrogen and played the part of its displaced rival, so that the chemical and physical properties of the substitution-product were thought to remain substantially the same as those of the original body. A singular story is connected with this discovery. At a *soirée* in the Tuileries in the time of Charles X. the guests were almost suffocated by acrid vapours which were evidently emitted by the burning wax candles, and the great chemist Dumas was called in to examine into the cause of the annoyance. He found that the wax of which the candles were made had been bleached by chlorine, that a replacement of some of the hydrogen atoms of the wax by chlorine had occurred, and that the suffocating vapours consisted of hydrochloric acid given off during the combustion. The wax was as white and as odourless as before, and the fact of the substitution of chlorine for hydrogen could only be recognised when the candles were destroyed by burning. This incident induced Dumas to investigate more closely this class of phenomena, and the results of this investigation are embodied in his law of substitution. So far indeed did the interest of the French school of chemists lead them that some assumed that not only the hydrogen but also the carbon of organic bodies could be replaced by substitution. Against this idea Liebig protested, and in a satirical vein he informs the chemical public—writing from Paris under the *nom de plume* of S. Windler—that he has succeeded in substituting not only the hydrogen but the oxygen and carbon in cotton cloth by chlorine, and he adds that the London shops are now selling nightcaps and other articles of apparel made entirely of chlorine, goods which meet with much favour, especially for hospital use!

But the debt which chemistry, both inorganic and organic, thus owes, to Dumas' law of substitution is serious enough, for it proved to be the germ of Williamson's classical researches on etherification, as well as of those of Wurtz and Hofmann on the compound ammonias, investigations which lie at the base of the structure of

modern chemistry. Its influence has been, however, still more far-reaching, inasmuch as upon it depends in great measure the astounding progress made in the wide field of organic synthesis.

It may here be permitted to me to sketch in rough outline the principles upon which all organic syntheses have been effected. We have already seen that as soon as the chemical structure of a body has been ascertained its artificial preparation may be certainly anticipated, so that the first step to be taken is the study of the structure of the naturally occurring substance which it is desired to prepare artificially by resolving it into simpler constituents, the constitution oi which is already known. In this way, for example, Hofmann discovered that the alkaloid coneine —the poisonous principle of hemlock—may be decomposed into a simpler substance well known to chemists under rhe name of pyridine. This fact having been established by Hofmann, and the grouping of the atoms approximately determined, it was then necessary to reverse the process, and, starting with pyridine, to build up a compound of the required constitution and properties, a result recently achieved by Ladenberg in a series of brilliant researches. The well-known synthesis of the colouring-matter of madder by Graebe and Liebermann, preceded by the important researches of Schunck, and that of indigo by Baeyer, are other striking examples in which this method has been successfully followed.

Not only has this intimate acquaintance with the changes which occur within the molecules of organic compounds been utilised, as we have seen, in the synthesis of naturally occurring substances, but it has also led to the discovery of many new ones. Of these, perhaps the most remarkable instance is the production of an artificial sweetening agent termed saccharin, 250 times sweeter than sugar, prepared by a complicated series of reactions from coal-tar. Nor must we imagine that these discoveries are of scientific interest only, for they have given rise to the industry of the coal-tar colours, the value of which is measured by millions sterling annually, an industry which Englishmen may be proud to remember was founded by our countryman Perkin.

Another interesting application of synthetic chemistry to the needs of everyday life is the discovery of a series of valuable febrifuges, amongst which I may mention antipyrin as the most useful. An important aspect in connection with the study of these bodies is the physiological value which has been found to attach to the introduction of certain organic radicals, so that an indication is given of the possibility of preparing a compound which will possess certain desired physiological properties, or even to foretell the kind of action which such bodies may exert on the animal economy.

But it is not only the physiological properties of chemical compounds which stand in intimate relation with their constitution, for we find that this is the case with all their physical properties. It is true that at the beginning of our period any such relation was almost unsuspected, whilst at the present time the number of instances in which this connection has been ascertained is almost infinite. Amongst these perhaps the most striking is the relationship which has been pointed out between the optical properties and chemical composition. This was in the first place recognised by Pasteur in his classical researches on racemic and tartaric acids in 1848; but the first to indicate a quantitative relationship and a connection between chemical structure and optical properties was Gladstone in 1863. Great instrumental precision has been brought to bear on this question, and consequently most important practical applications have resulted. I need only refer to the well-known accurate methods now in everyday use for the determination of sugar by the polariscope, equally valuable to the physician and to the manufacturer.

But now the question may well be put, Is any limit set to this synthetic power of the chemist? Although the danger oi dogmatising as to the progress of science has already been shown in too many instances, yet one cannot help feeling that the barrier which exists between the organised and unorganised worlds is one which the chemist at present sees no chance of breaking down.

It is true that there are those who profess to foresee that the day will arrive when the chemist, by a succession of constructive efforts, may pass beyond albumen, and gather the elements of lifeless matter into a living structure. Whatever may be said regarding this from other standpoints, the chemist can only say that at present no such problem lies within his province. Protoplasm, with which the simplest manifestations of life are associated, is not a compound, but a structure built up of compounds. The chemist may successfully synthesise any of its component molecules, but he has no more reason to look forward to the synthetic production of the structure than to imagine that the synthesis of gallic acid leads to the artificial production of gall-nuts.

Although there is thus no prospect of our effecting a synthesis of organised material, yet the progress made in our knowledge of the chemistry of life during the last fifty years has been very great, and so much so indeed that the sciences of physiological and of pathological chemistry may be said to have entirely arisen within this period.

In the introductory portion of this address I have already referred to the relations supposed to exist fifty years ago between vital phenomena and those of the inorganic world. Let me now briefly trace a few of the more important steps which have marked the progress of this branch of science during this period. Certainly no portion of our science is of greater interest, nor, I may add, of greater complexity, than that which, bearing on the vital functions both of plants and of animals, endeavours to unravel the tangled skein of the chemistry of life, and to explain the principles according to which our bodies live, and move, and have their being. If, therefore, in the less complicated problems with which other portions of our science have to deal, we find ourselves, as we have seen, often far from possessing satisfactory solutions, we cannot be surprised to learn that with regard to the chemistry of the living body—whether vegetable or animal—in health or disease we are still farther from a complete knowledge of phenomena, even those of fundamental importance.

It is of interest here to recall the fact that nearly fifty years ago Liebig presented to the Chemical Section of this Association a communication in which, for the first time, an attempt was made to explain the phenomena of life on chemical and physical lines, for in this paper he admits the applicability of the great principle of the conservation of energy to the functions of animals, pointing out that the animal cannot generate more heat than is produced by the combustion of the carbon and hydrogen of his food.

"The source of animal heat," says Liebig, "has previously been ascribed to nervous action or to the contraction of the muscles, or even to the mechanical motions of the body, as if these motions could exist without an expenditure of force [equal to that] consumed in producing them." Again he compares the living body to a laboratory furnace in which a complicated series of changes occur in the fuel, but in which the end-products are carbonic acid and water, the amount of heat evolved being dependent, not upon the intermediate, but upon the final products. Liebig asked himself the question, does every kind of food go to the production of heat; or can we distinguish, on the one hand, between the kind of food which goes to create warmth, and, on the other, that by the oxidation of which the motions and mechanical energy of the body are kept up? He thought that he was able to do this, and he divided food into two categories; the starchy or carbohydrate food is that, said he, which by its combustion provides the warmth necessary for the existence and life of the body. The albuminous or nitrogenous constituents of our food, the flesh meat, the

gluten, the casein out of which our muscles are built up, are not available for the purposes of creating warmth, but it is by the waste of those muscles that the mechanical energy, the activity, the motions of the animal are supplied. "We see," said Liebig, "that the Esquimaux feeds on fat and tallow, and this burning in his body keeps out the cold. The Gaucho, riding on the pampas, lives entirely on dried meat, and the rowing man and pugilist, trained on beefsteaks and porter, require little food to keep up the temperature of their bodies, but much to enable them to meet the demand for fresh muscular tissue, and for this purpose they need to live on a strongly nitrogenous diet."

Thus far Liebig. Now let us turn to the present state of our knowledge. The question of the source of muscular power is one of the greatest interest, for, as Frankland observes, it is the corner-stone of the physiological edifice and the key to the nutrition of animals.

Let us examine by the light of modern science the truth of Liebig's view—even now not uncommonly held—as to the functions of the two kinds of food, and as to the cause of muscular exercise being the oxidation of the muscular tissue. Soon after the promulgation of these views, J. R. Mayer, whose name as the first expositor of the idea of the conservation of energy is so well known, warmly attacked them, throwing out the hypothesis that all muscular action is due to the combustion of food, and not to the destruction of muscle, proving his case by showing that if the muscles of the heart be destroyed in doing mechanical work the heart would be burnt up in eight days! What does modern research say to this question? Can it be brought to the crucial test of experiment? It can; but how? Well, in the first place we can ascertain the work done by a man or any other animal; we can measure this work in terms of our mechanical standard, in kilogramme-metres or foot-pounds. We can next determine what is the destruction of nitrogenous tissue at rest and under exercise by the amount of nitrogenous material thrown off by the body. And here we must remember that these tissues are never completely burnt, so that free nitrogen is never eliminated. If now we know the heat-value of the burnt muscle, it is easy to convert this into its mechanical equivalent, and thus measure the energy generated. What is the result? Is the weight of muscle destroyed by ascending the Faulhorn or by working on the treadmill sufficient to produce on combustion heat enough when transformed into mechanical exercise to lift the body up to the summit of the Faulhorn or to do the work on the treadmill? Careful experiment has shown that this is so far from being the case that the actual energy developed is twice as great as that which could possibly be produced by the oxidation of the nitrogenous constituents eliminated from the body during twenty-four hours. That is to say, taking the amount of nitrogenous substance cast off from the body, not only whilst the work was being done but during twenty-four hours, the mechanical effect capable of being produced by the muscular tissue from which this cast-off material is derived would only raise the body halfway up the Faulhorn, or enable the prisoner to work half his time on the treadmill.

Hence it is clear that Liebig's proposition is not true. The nitrogenous constituents of the food do doubtless go to repair the waste of muscle, which, like every other portion of the body, needs renewal, whilst the function of the non-nitrogenous food is not only to supply the animal heat, but also to furnish, by its oxidation, the muscular energy of the body.

We thus come to the conclusion that it is the potential energy of the food which furnishes the actual energy of the body, expressed in terms either of heat or of mechanical work.

But there is one other factor which comes into play in this question of mechanical energy, and must be taken into account; and this factor we are as yet unable to estimate in our usual terms. It concerns the action of the mind upon the body, and, although incapable of exact expression, exerts none the less an important influence on the physics and chemistry of the body, so that a connection undoubtedly exists between intellectual activity or mental work and bodily nutrition. In proof that there is a marked difference between voluntary and involuntary work, we need only compare the mechanical action of the heart, which never causes fatigue, with that of the voluntary muscles, which become fatigued by continued exertion. So, too, we know well that an amount of drill which is fatiguing to the recruit is not felt by the old soldier, who goes through the evolutions automatically. What is the expenditure of mechanical energy which accompanies mental effort, is a question which science is probably far removed from answering. But that the body experiences exhaustion as the result of mental activity is a well recognised fact. Indeed, whilst the second law of thermodynamics teaches that in none of the mechanical contrivances for the conversion of heat into actual energy can such a conversion be complete, it is perhaps possible, as Helmholtz has suggested, that such a complete conversion may take place in the subtle mechanism of the animal organism.

The phenomena of vegetation, no less than those of the animal world, have, however, during the last fifty years been placed by the chemist on an entirely new basis. Although before the publication of Liebig's celebrated report on chemistry and its application to agriculture, presented to the British Association in 1840, much had been done, many fundamental facts had been established, still Liebig's report marks an era in the progress of this branch of our science. He not only gathered up in a masterly fashion the results of previous workers, but put forward his own original views with a boldness and frequently with a sagacity which gave a vast stimulus and interest to the questions at issue. As a proof of this I may remind you of the attack which he made on, and the complete victory which he gained over, the humus theory. Although Saussure and others had already done much to destroy the basis of this theory, yet the fact remained that vegetable physiologists up to 1840 continued to hold to the opinion that humus, or decayed vegetable matter, was the only source of the carbon of vegetation. Liebig, giving due consideration to the labours of Saussure, came to the conclusion that it was absolutely impossible that the carbon deposited as vegetable tissue over a given area, as for instance over an area of forest land, could be derived from humus, which is itself the result of the decay of vegetable matter. He asserted that the whole of the carbon of vegetation is obtained from the atmospheric carbonic acid, which, though only present in the small relative proportion of four parts in 10,000 of air, is contained in such absolutely large quantity that if all the vegetation on the earth's surface were burnt, the proportion of carbonic acid which would thus be thrown into the air would not be sufficient to double the present amount.

That this conclusion of Liebig's is correct needed experimental proof, but such proof could only be given by long-continued and laborious experiment, and this serves to show that chemical research is not now confined to laboratory experiments lasting perhaps a few minutes, but that it has invaded the domain of agriculture as well as of physiology, and reckons the periods of her observations in the field not by minutes, but by years. It is to our English agricultural chemists Lawes and Gilbert that we owe the complete experimental proof required. And it is true that this experiment was a long and tedious one, for it has taken forty-four years to give the definite reply. At Rothamsted a plot was set apart for the growth of wheat. For forty-four successive years that field has grown wheat without addition of any carbonised manure; so that the only possible source from which the plant could obtain the carbon for its growth is the atmospheric carbonic acid. Now, the quantity of carbon which on an average was removed in the form of wheat and straw from a plot

manured only with mineral matter was 1000 pounds, whilst on another plot, for which a nitrogenous manure was employed, 1500 pounds more carbon was annually removed, or 2500 pounds of carbon are removed by this crop annually without the addition of any carbonaceous manure. So that Liebig's prevision has received a complete experimental verification.

May I, without wearying you with experimental details, refer for a moment to Liebig's views as to the assimilation of nitrogen by plants—a much more complicated and difficult question than the one we have just considered—and compare these with the most modern results of agricultural chemistry? We find that in this case his views have not been substantiated. He imagined that the whole of the nitrogen required by the plant was derived from atmospheric ammonia; whereas Lawes and Gilbert have shown by experiments of a similar nature to those just described, and extending over a nearly equal length of time, that this source is wholly insufficient to account for the nitrogen removed in the crop, and have come to the conclusion that the nitrogen must have been obtained either from a store of nitrogenous material in the soil or by absorption of free nitrogen from the air. These two apparently contradictory alternatives may perhaps be reconciled by the recent observations of Warington and of Berthelot, which have thrown light upon the changes which the so-called nitrogenous capital of the soil undergoes, as well as upon its chemical nature, for the latter has shown that under certain conditions the soil has the power of absorbing the nitrogen of the air, forming compounds which can subsequently be assimilated by the plant.

Touching us as human beings even still more closely than the foregoing, is the influence which chemistry has exerted on the science of pathology, and in no direction has greater progress been made than in the study of micro-organisms in relation to health and disease. In the complicated chemical changes to which we give the names of fermentation and putrefaction, the views of Liebig, according to which these phenomena are of a purely chemical character, have given way under the searching investigations of Pasteur, who established the fundamental principle that these processes are inseparably connected with the life of certain low forms of organisms. Thus was founded the science of bacteriology which in Lister's hands has yielded such splendid results in the treatment of surgical cases; and in those of Klebs, Koch, and others, has been the means of detecting the cause of many diseases both in man and animals; the latest and not the least important of which is the remarkable series of successful researches by Pasteur into the nature and mode of cure of that most dreadful of maladies, hydrophobia. And here I may be allowed to refer with satisfaction to the results of the labours on this subject of a committee, the formation of which I had the honour of moving for in the House of Commons. These results confirm in every respect Pasteur's assertions, and prove beyond a doubt that the adoption of his method has prevented the occurrence of hydrophobia in a large proportion of persons bitten by rabid animals, who, if they had not been subjected to this treatment would have died of that disease. The value of his discovery is, however, greater than can be estimated by its present utility, for it shows that it may be possible to avert other diseases besides hydrophobia by the adoption of a somewhat similar method of investigation and of treatment. This, though the last, is certainly not the least of the debts which humanity owes to the great French experimentalist. Here it might seem as if we had outstepped the boundaries of chemistry, and have to do with phenomena purely vital. But recent research indicates that this is not the case, and points to the conclusion that the microscopist must again give way to the chemist, and that it is by chemical rather than by biological investigation that the causes of diseases will be discovered, and the power of removing them obtained. For we learn that the symptoms of infective diseases are no more due to the microbes which constitute the infection than alcoholic intoxication is produced by the yeast-cell, but that these symptoms are due to the presence of definite chemical compounds, the result of the life of these microscopic organisms. So it is to the action of these poisonous substances formed during the life of the organism, rather than to that of the organism itself, that the special characteristics of the disease are to be traced; for it has been shown that the disease can be communicated by such poisons in entire absence of living organisms.

If I have thus far dwelt on the progress made in certain branches of pure science it is not because I undervalue the other methods by which the advancement of science is accomplished, viz., that of the application and of the diffusion of a knowledge of nature, but rather because the British Association has always held, and wisely held, that original investigation lies at the root of all application, so that to foster its growth and encourage its development has for more than fifty years been our chief aim and wish.

Had time permitted I should have wished to have illustrated this dependence of industrial success upon original investigation, and to have pointed out the prodigious strides which chemical industry in this country has made during the fifty years of her Majesty's reign. As it is I must be content to remind you how much our modern life, both in its artistic and useful aspects, owes to chemistry, and, therefore, how essential a knowledge of the principles of the science is to all who have the industrial progress of the country at heart.

This leads me to refer to what has been accomplished in this country of ours towards the diffusion of scientific knowledge amongst the people during the Victorian era. It is true that the English people do not possess, as yet, that appreciation of the value of science so characteristic of some other nations. Up to very recent years our educational system, handed down to us from the middle ages, has systematically ignored science, and we are only just beginning, thanks in a great degree to the prevision of the late Prince Consort, to give it a place, and that but an unimportant one, in our primary and secondary schools or in our universities. The country is, however, now awakening to the necessity of placing its house in order in this respect, and is beginning to see that if she is to maintain her commercial and industrial supremacy the education of her people from top to bottom must be carried out on new lines. The question as to how this can be most safely and surely accomplished is one of transcendent national importance, and the statesman who solves this educational problem will earn the gratitude of generations yet to come.

In conclusion, may I be allowed to welcome the unprecedentedly large number of foreign men of science who have on this occasion honoured the British Association by their presence, and to express the hope that this meeting may be the commencement of an international scientific organisation, the only means nowadays existing, to use the words of one of the most distinguished of our guests, of establishing that fraternity among nations from which politics appear to remove us further and further by absorbing human powers and human work, and directing them to purposes of destruction. It would indeed be well if Great Britain, which has hitherto taken the lead in so many things that are great and good, should now direct her attention to the furthering of international organisations of a scientific nature. A more appropriate occasion than the present meeting could perhaps hardly be found for the inauguration of such a movement.

But whether this hope be realised or not, we all unite in that one great object, the search after truth for its own sake, and we all, therefore, may join in re-echoing the words of Lessing: "The worth of man lies not in the truth which he possesses, or believes that he possesses, but in the honest endeavour which he puts forth to secure that truth; for not by the possession of truth, but by the search after it are the faculties of man enlarged, and in

this alone consists his ever-growing perfection. Possession fosters content, indolence, and pride. If God should hold in His right hand all truth, and in His left hand the ever-active desire to seek truth, though with the condition of perpetual error, I would humbly ask for the contents of the left hand, saying, 'Father, give me this; pure truth is only for thee.'"

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 89).

Extract (1).

My attention was not directed to the presence of saponin in *extract*(1), for the characteristic properties which it imparted to *extracts* (2), (3), and (4), were absent; but, it was evident that saponin was present in the bark, for on boiling the latter in distilled water, the presence of the compound was indicated. The solution frothed on shaking, and by adding a concentrated solution of caustic baryta, saponin-baryta was precipitated.†

A colouring matter‡ contained in the bark was extracted, and imparted to the *alcoholic extract* a brilliant red colour. It was precipitated by sub-acetate of lead, and the lead precipitate suspended in water and decomposed by sulphuretted hydrogen. The lead sulphide filtrate was evaporated over a water-bath until the odour of sulphuretted hydrogen was expelled, and the concentrated liquid was placed over sulphuric acid to evaporate slowly. A crystalline residue was obtained. On addition of alkalies to the colourless lead sulphide filtrate the red colour of the original solution was developed. Acid discharged the colour. Acetic ether took up the red coloured substance. The acetic ether residue was a red uniform solid, and soluble in water. It was precipitated from the aqueous solution by sub-acetate of lead, potassium bichromate, ferric chloride, ferrous sulphate, and it was clouded by alum, and stannous chloride solutions.

Tannin, gallic acid, and alkaloids were absent.

Amyl alcohol separated from the acidified aqueous extract white needle-shaped crystals. It was not determined if these crystals were the same as those of the colouring matter.

Extracts (2), (3), *and* (4).

Extracts (2) and (3) when warm were clear, and on cooling a creamy-white solid separated. Extract (4), if warmed, was turbid, and as the liquid cooled, a creamy-white substance remained at the bottom of the flask, and the supernatant fluid became clear. This creamy-white substance was identified in each of the *extracts* as saponin§.

The results following an aqueous treatment of *alcoholic residues* (2) and (3) were noticeable. The *residues* were dissolved, and by shaking the mixtures, emulsified. This emulsion was permanent, as no resinous matter separated on standing several days. The emulsion was agitated with acetic ether, and by this means most of the resin and saponin were separated from the aqueous portion. The saponin was removed mechanically with the resin, as it is almost insoluble in acetic ether. The resin-saponin mass was insoluble in ether, soluble in water. The solution frothed on shaking and emulsified, but the emulsion was not so permanent as in the first case, for a resinous sediment settled after a time. Chloroform separated saponin from an acidified aqueous solution, and also from an alkaline aqueous solution of the *residues*; and the red-violet saponin reaction with concentrated sulphuric acid was obtained.

The solubility in water of the *alcoholic residues* (2), (3)' and (4), and the resulting emulsion were unusual, and explicable by the facts collected from a series of experiments with resins and saponin, since I had successfully emulsified resins with aqueous and alcoholic saponin solutions.*

By hot alcoholic treatment the *yucca* yielded a residue of saponin and resin which became emulsified on the addition of water, giving results identical with those of the resins above described.†

Extract (4) contained a resin. It was an opaque reddish yellow coloured substance, and it differed, by its reactions, from the many resin classes given in Hirschsohn's scheme. It is propose to name it pyrophæal.‡ A resin having the same melting point, solubilities, physical appearance, and chemical reactions, was discovered in the *ethereal extract* (4). It was identified as the same compound for which the name pyrophæal is proposed.

Tannin, gallic acid, and alkaloids were not detected in *extracts* (2), (3), and (4). In *extract* (3) glucose was not found.

Summary III.—*Alcoholic Extracts.*

	Solids extracted.	Character of residue.	Reaction with litmus.	Quantitative estimation of glucose.	Quantitative estimation of saccharose or other reducible compounds
1. The bark of the root ..	9·25 p.c. 0·20 p.c. ash	Red colouring matter crystalline.	Neutral.	0·619 p.c.	0·180 p.c.
2. „ wood „	14·30 „ 0·10 „	Resin, saponin.	„	1·592 „	0·929 „
3. „ green leaf	3·80 „ 0·15 „	Resins, „	„	none	none
4. „ yellow base of leaf..	4·30 „ 0·05 „	Resin, „	Slightly acid.	traces	traces

The Solids of the Alcoholic Extracts.

I. A red colouring matter (crystalline).
II. A new resin (yuccal).§
III. A second new resin (pyrophæal).§
IV. A mixture of a crystalline resin and a resin anhydride.
V. Saponin.§
VI. Glucose, and saccharose or other reducible compounds.
VII. Ash.

(To be continued).

* Reprinted from the *Transactions of the American Philosophical Society.*

† Saponin in the bark of *Yucca angustifolia. Science*, September 11, 1885.

‡ A red crystalline colouring matter. *Science*, September 11, 1885.

§ Saponin in the wood of the root and leaves. *Science*, September 11, 1885.

* The same kinds of resins were used in these experiments as in those with which I determined the solubility of resins in acetic ether. See foot-note (2), *ethereal extract* (2).

† It was not until a later date following the time of these experiments that I found a reference to saponin-resin emulsion in L'Officine ou Répertoire General de Pharmacie Pratique, par Dorvault. Huitième Edition, Paris, 1872, p. 816. Also, refer to examination of the *Yucca angustifolia*, by H. C. De S. Abbott, published in the *Medical and Surgical Reporter*, Philadelphia, September 12, 1885, p. 301.

‡ Pyrophæal, *loc. cit.*

§ *Science*, September 11, 1885, p. 210. Abstract of a paper on the chemical study of *Yucca angustifolia* by H. C. De S. Abbott.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JULY 31ST, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To THE WATER EXAMINER, *Metropolis Water Act*, 1871.

London, August 5th, 1887.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from July 1st to July 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The water supply of the past month was characterised by an appreciable diminution in the habitually small proportion of organic matter present. In the case of the companies taking their supply from the Thames, the mean amount of organic carbon was 0·146 part, and the maximum in any one sample 0·169 part in 100,000 parts of the water, corresponding respectively to about one quarter of a grain, and to about three-tenths of a grain of organic matter per gallon. More marked even than the diminution of its proportion of organic matter was the increased degree of freedom of the water from other than a bluish tint of colour. The slight turbidity manifest occasionally for some months past in the East London Company's water, was noticeable during the past month, and that to a very insignificant extent, in two samples only.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

NOTICES OF BOOKS.

Studies from the Laboratory of Physiological Chemistry of Yale University. For the year 1885-86. Vol. II. Edited by R. H. CHITTENDEN, Ph.D., Professor of Physiological Chemistry. Newhaven: Tuttle, Morehouse, and Taylor.

DR. CHITTENDEN here records the results of a series of important investigations in physiological chemistry. He has examined the alleged dehydration of glucose in the stomach and intestines, but finds himself unable to confirm the view of Dr. F. W. Pavy, that glucose is not the final product of amylolytic action, but is capable of transformation within the animal system into a compound which has less power of reducing cupric oxide. It is incidentally mentioned that M. Ogata, who experimented on dogs, was unable to confirm Dr. Pavy's results.

In concert with M. T. Hutchinson the author has studied the influence of uranium salts on the amylolytic action of saliva, and the proteolytic action of pepsine and trypsine. This paper is only the beginning of an inquiry into the physiological and toxic action of uranium salts.—a subject as yet very imperfectly investigated. The authors acknowledge in the outset the kindness of Prof. H. Carrington Bolton in supplying them with a sufficiency of pure compounds of uranium. The various uranium salts tried were found to have a decidedly inhibitory action on the transformation of starch under the action of saliva.

The manner in which the uranium salts diminish the amylolytic action of the ferment has not been directly ascertained. The authors consider the loss of power due in part to a partial direct destruction of the ferment, as well as to a change in the reaction of the fluid.

Proteolytic action is also retarded by the uranium salts.

The next subject studied is the relative distribution of antimony in the organs and tissues of the body under various conditions. This is a question of no small practical importance, since the relative proportion of poison found in the different tissues after death may prove of chemico-legal importance.

The first point to be ascertained was the determination of antimony existing in admixture with large quantities of organic matter, solid or liquid. The electrolytic method was found to give satisfactory results.

As regards the distribution of the poison in the system the authors not unnaturally expected that, as in the case of arsenic, soluble and easily diffusible forms of the poison would be absorbed by the brain in appreciable quantities. With antimony the results tend in the same direction, but are not so decisive as it might be wished.

Prof. Chittenden, assisted by J. A. Blake, has also studied the influence of antimonious oxide on metabolism. Small repeated doses of this compound are without influence on the elimination of nitrogen, sulphur, and phosphorus, and it has hence in non-poisonous doses no influence on proteid metabolism. Grohe and Mossler, however, have shown that antimony, regularly taken, induces fatty degeneration of the liver, kidneys, and heart. This fact has long been utilised in the production of the *foies gras* so beloved of gourmets. That morbid tissues, animal or vegetable, are unfit for human food can scarcely be seriously questioned.

It will be seen that the researches described in the last two papers could not have been undertaken in England without the arbitrary and capricious permission of the Home Secretary. To administer antimony to dogs or rabbits in order to ascertain its ultimate distribution and its influence, would be vivisection, and would consequently be deemed a "horrible sin." But to give it to geese for the promotion of gastronomy is, we presume, a meritorious act.

The remaining memoirs relate to globuline and globulose bodies, the peptones, some metallic compounds of albumen and myosin, egg-albumen and albumoses, casein and its primary splitting products, and the influence of some organic and inorganic substances on the metabolism of gases.

Exhibition of Petroleum Products.—During the autumn of the present year there will be held at St. Petersburg an Exhibition of Petroleum Products and Lighting Appliances. The Ministry of Imperial Domains offer a prize of 2500 roubles for the best cheap and simple lamp to burn heavy naphtha oils, and one of 1000 roubles for a more expensive lamp to burn the same kind of oil. The Ministry of War offers 500 roubles for a stove to heat rooms, burning naphtha waste; the same sum for a compact galvanic battery for actuating glow-lamps; a prize of 1000 roubles for an apparatus for night and day signalling, and one of 500 roubles for phosphorescent materials. The latest term for receiving exhibits is November 27. All articles must be addressed to the Exhibition Executive Commission of the Imperial Technical Society, St. Petersburg, Panteleimonovskaja, No. 2.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxvi., Part 1.

The Carbolic Acids of Commerce.—C. Castelhaz.—From the *Bulletin de la Soc. Chimique de Paris.*

Specific Gravity of Solid, Melted, and Dissolved Paraffin.—G. Beilby.—From the *Journal of the Chemical Society.*

Detection of Free Sulphuric Acid in Aluminium Sulphate.—Hager.—The author heats 2 drops of gurjum balsam in a test-tube with 3 c.c. acetic acid, shaking up frequently. He adds about 0·25 of the pulverised aluminium sulphate, and heats with agitation again if the mixture has become cold. If traces of free sulphuric acid are present a light blue colour appears in about ten minutes. In the absence of free sulphuric acid the mixture appears yellowish or whitish yellow, and does not turn blue even in the course of many hours.

Apparatus for the Speedy Examination of Hydrogen Peroxide.—M. Martinon.—From the *Bulletin de la Soc. Chimique.*

Rapid Determination of Carbon in Cast-Metal, Steel, and Wrought Iron.—M. Zaboudsky.—From the *Bulletin de la Société Chimique.*

Analysis of Soils.—Antony Guyard.—From the *Bulletin de la Société Chimique.*

R. Palm's Process for obtaining Digitaline, Digitaleine, and Digitine.—According to A. Peltz and C. Leuken this process yields no alkaloids.

Examination of Extractum Belladonnæ.—An account of the processes of H. Kunz, W. Dunstan, F. Ranson, and O. Schweissinger.

Determination of Mercury in Urine.—A. Wolff and J. Nega render the process of Ludwig and Fürbringer more sensitive by combining it with the previous destruction of the organic matters and precipitation with hydrogen sulphide as recommended by Schridde.

Volumetric Determination of Total Nitrogen in Urine.—Horbaczewski simplifies Ludwig's process by dispensing with the previous concentration of the urine.

New Process for Determining Urea in Urine with Bromine Water.—Pflüge finds that good results may be obtained with diluted bromine water if the urea is previously converted into ammonium carbonate by means of strong soda lye.

The Presence of Sugar in Normal Human Urine.—C. Schilder.—By means of phenylhydrazine traces of sugar can be detected in all urine.

A Novel Reaction of Creatinine.—M. Jaffé.—If a solution of creatinine is mixed with an aqueous solution of picric acid and a few drops of dilute soda lye, it turns at once of an intense red. The depth of the colour, which varies from orange red to dark blood red, increases considerably in the first minutes and remains then unchanged for hours, but if the alkali is in excess it goes back to a yellow, especially on exposure to light. Acidulation with acetic or hydrochloric acid effects this change in a few minutes. Sodium picrate is of a pure yellow colour, and cannot be mistaken for the red colouration of creatinine. No other constituent of urine gives the reaction in the manner described. Creatinine gives a pure yellow, which passes into a red only after standing for some hours in the cold. Glucose does not yield, in the cold, the well known blood-red colour depending on the reduction of picric acid, or only after prolonged standing. Acetone certainly gives in the cold a faint reddish yellow shade, which, however, cannot be confounded with the redder and more intense reaction.

Albumen in Normal Urine.—C. Posner confirms the results of earlier observers, showing the presence of minute traces of albumen in normal urine.

Estimation of Albumen in Urine by Means of Esbach's Albumenimeter.—J. E. Blomfield (*Lancet*) and P. Guttmann (*Berliner Klin. Wochenschrift*) find this method fully adequate for medical purposes.

The Precipitate caused by Picric Acid in Normal Urine.—M. Jaffé.—The precipitate is a double compound of creatinine picrate and potassium picrate.

Detection of Blood-Pigment in Urine.—C. Rosenthat.—The spectroscopic method, according to the author, is available only to a limited degree. He obtained better results by recognising the iron in the ash of the precipitate given by tannin.

Simple Spectroscopic Method for the Detection of Hæmatine.—E. Hering shows that it is in certain cases advantageous in the examination of coloured fluids to use not a spectroscope but a simple prism. It is sufficient to place the fluid in a sufficiently thick stratum before a narrow slit cut in black paper, and to examine it against the light with a prism whose refractive edge is about 60°. The absorption bands appear as narrow sharply defined lines in the short spectrum.

Determination of Hæmoglobine in Blood.—E. v. Fleischl.—A description of the author's hæmometer for a colorimetric determination of the colouring-matter of blood, with an exactitude sufficient for clinical purposes.

Distribution of Arsenic in the Human Body.—R. H. Chittenden.—The particulars are not given, the reader being referred to the original paper in the *American Chemical Journal.*

Detection of Blood-Spots in Presence of Iron-Rust.—E. Dannenberg.—Already noticed.

Atomic Weight of Uranium.—Clemens Zimmermann.—Already noticed under *Liebig's Annalen.*

MISCELLANEOUS.

British Association for the Advancement of Science.—Section B.—The following is a preliminary list of the Papers which will be brought forward in the Chemical Section :—

F. W. Clarke.—The Chemical Structure of Natural Silicates.

J. W. Mallet, F.R.S.—Preliminary Notice of a Redetermination of the Atomic Weight of Gold, with some Remarks on the Present State of our Knowledge as to the Determination of Atomic Weights in General.

Dr. G. H. Bailey.—The Atomic Weight of Zirconium.

Dr. G. H. Bailey.—The Absorption Spectra of the Rare Earths, with Special Reference to the Recent Announcement of New Elements.

Dr. G. H. Bailey and Professor Schuster, F.R.S.—The Absorption Spectra of the Salts of Didymium under Polarised Light.

W. Thomson.—On the Antiseptic Properties of some Fluorine Compounds.

Prof. Carnelley.—The Antiseptic Properties of Metallic Salts in relation to their Chemical Composition.

Dr. A. Richardson.—Action of Light on the Hydracids of the Halogens in presence of Oxygen.

Prof. Dunstan and T. S. Dymond.—Reduction Products of the Nitro-Paraffin and Alkyl Nitrites.

John A. Hall.—Organic Vanadates.

Dr. Noelting.—The Six Isomeric Azoxylols.

Dr. Noelting.—On Substitution in the Azo Compounds.

Dr. Noelting.—On Azo-imido Compounds.

Prof. Carnelley and Dr. A. Thomson.—The Solubility of Isomeric Organic Compounds.

Prof. Carnelley.—The Melting-points of Organic Compounds in relation to their Chemical Constitution.

Prof. A. Berntham.—Some New Facts connected with some of the Colouring Matters.

Dr. C. Fahlberg.—Saccharine.

Dr. O. N. Witt.—The Constitution and Relationship of the Eurhodine and Saffranine Classes of Colouring-Matters, and their Connection with other Groups of Organic Compounds.

Dr. F. H. Bowman.—On the Present Condition of our Knowledge of the Chemical Composition of Cotton-Wool.

Prof. W. H. Perkin and Dr. J. B. Cohen.—Some New Cinnamic Acids.

W. B. Hart.—Some Organo-Silicon Compounds.

Dr. Bott and Prof. Schwarz.—The Derivatives and Constitution of the Pyrocresols.

Dr. Bott.—A New and Rapid Method of Testing Beer and other Alcoholic Liquors.

W. Durham.—Solution.

Dr. C. R. Alder Wright, F.R.S., and C. Thompson.—Notes on some Peculiar Voltaic Combinations.

Prof. Smithells.—Suggested Amendment of Chemical Nomenclature.

Prof. Sterry Hunt,—Integral Weights in Chemistry.

Dr. Springer.—Torsion Balances.

F. W. Watkin, M.A.—Apparatus suitable for Lecture Purposes for determining the Volume of Gas evolved in various Chemical Actions, with or without the application of Heat.

J. W. Mallet, F.R.S.—On a Partial Separation of the Constituents of a Solution during Expansion by Rise of Temperature.

J. W. Langley.—On a Probable Manifestation of Chemical Attraction as a Mechanical Stress.

Prof. Lunge.—On the Composition of some Coke-Oven Tars of German Origin.

Prof. Lunge.—A New Apparatus for Condensing Gases by Contact with Liquids.

Watson Smith.—On the Constituents of the Light Oils of Blast-Furnace Coal Tar from the Gartsherrie Works.

A. E. Fletcher.—The Present Position of the Alkali Trade.

T. Fairley.—Vacuum Injector Pumps for use in Chemical Laboratories.

Prof. Carnelley.—A New Method for Determining Micro-Organisms in Air.

R. Warington.—Reduction of Nitrates by Micro-Organisms.

Charles O'Neill.—The Extent to which Calico Printing and the Tinctorial Arts have been affected by the Introduction of Modern Colours.

M. M. Pattison Muir, M.A.—The Teaching of Chemistry.

Dr. Gilbert, F.R.S.—The Origin of Nitrogen in Plants.

Prof. H. E. Armstrong.—Valency.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Test for Tall w.—Can any of your readers give me particulars respecting the new test for tallow which I believe is known as the "Tita" test, how used, and for what purposes employed?—H. N. Warren.

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The Board requires the Services of an Assistant-Master for the Birmingham Bridge Street Seventh Standard Technical School. Salary £120 per annum. It is essential that the person appointed should be thoroughly qualified in Mathematics, Chemistry, and Physics.

Applications, enclosing copies of Testimonials, to be sent in on or before the 14th day of September, addressed to the Clerk of the School Board, Edmund Street, Birmingham.

The London Hospital and Medical College, MILE END, E.

The SESSION 1887-88 will commence on Saturday, October 1st, 1887. The New Buildings which were opened by T.R.H. The Prince and Princess of Wales, on May 21st, afford more than double the accommodation which was provided formerly.

Four Entrance Scholarships, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All Resident and other Hospital Appointments are free, and the holders of all the Resident Appointments are provided with rooms and board entirely free of expense. The Resident Appointments consist of five House Physiciancies, five House Surgeoncies, one Accoucheurship, and one Receiving-room Officer; Dressers and Maternity Pupils also reside in the Hospital. Special Classes for the Preliminary Scientific and Intermediate M.B. Examinations of the University of London and for the Primary and Pass Examinations for the Fellowship of the Royal College of Surgeons of England are held throughout the year. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis, and the Metropolitan, Metropolitan District, East London, and South-Eastern Railways have stations within a minute's walk of the Hospital and College.

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THE CHEMICAL NEWS.

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ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.*

By EDWARD SCHUNCK, Ph.D., F.R.S. F.C.S.,
President of the Section.

Ladies and Gentlemen,—It is, I can assure you, with a feeling of extreme diffidence that I take the chair to-day as President of the Chemical Section at this meeting of the British Association. When I look round me and see the many distinguished men who are prepared to take part in our proceedings I cannot but very strongly feel that the Council's choice might have fallen on a worthier representative of chemical science than myself. Having in the course of my career bestowed more time and attention to technical matters than to purely scientific subjects, and having moreover arrived at a time of life when active participation in work of any kind must necessarily be drawing to a close, you must not expect from me the accurate knowledge of the present state of chemical science and the questions that are at this moment presenting themselves for solution such as would naturally be required from anyone occupying the post which I have on this occasion the honour to hold. The marvellously rapid progress of chemistry during the last twenty years has made it difficult for the most industrious cultivator of the science to keep abreast of the knowledge of the day, and for a *dilettante* like myself one may say it is next to impossible. I confess myself painfully conscious of my defects in this respect, and I shall therefore have to claim the indulgence of the Section should questions arise on which I am unable to speak with authority, or even to discuss with advantage.

Considering, however, how efficiently I am supported by the gentlemen with whom I have the honour to be associated, and to whom I am sure in any case of difficulty I may appeal for assistance, I trust to be able to perform the duties of my office without discredit. I will not, however, trouble you with merely personal questions, which are always more or less tedious, but proceed with the few remarks which I wish to make, and which, if not new or instructive, may perhaps serve to entertain you during the time usually devoted to addresses of this kind.

I think you will hardly expect me, even were I fully competent to do so, to review the progress of chemistry during the last half-century, for the time at my disposal would be too short and the result at my hands, I fear, unsatisfactory. I shall prefer to call attention in a few words to the chemistry of other days as I knew it and the chemistry of the present time as known to us all, and to point out what I consider to be the chief characteristics of each. I shall then, with your permission, point out a few of the directions in which, in my opinion, the chemistry of the future will probably be developed, and in this undertaking I shall perhaps be more successful than in the other; for to discuss the history of science requires exact knowledge, but in speculating on its future the imagination comes into play, and to imagine is easier than to describe.

When I first entered on my studies, exactly fifty years ago, chemistry could hardly be called a science—it was rather a collection of isolated facts unconnected by any consistent theory covering the whole field. Most of the important elements were known, but of the exact proportions in which they combine together we were ignorant. The law of definite proportion had been generally accepted, but so imperfect were the data then at our disposal that we may say the law was rather taken for granted than proved. The atomic theory of Dalton as explaining this law had also been adopted by chemists; but it is not unlikely that this theory, then in its infancy, might by the vigorous onslaught of a man of Berthollet's acumen have been upset, and we should then have been left entirely without a guide through the bewildering labyrinth of facts. Of any connection between chemistry and physics there was in those days no question; of any but the most superficial notions regarding the effects of heat, light, and electricity on chemical substances we had no conception. The idea that chemistry could have any bearing on or connection with physiology or pathology would have been ridiculed as absurd. I cannot think of the then state of organic chemistry without feeling amused. The state of this branch of chemistry could hardly perhaps be called chaotic or rudimentary, for, after all, what had been done had been well done and neatly done, but the assemblage of facts of which it consisted was devoid of systematic arrangement; it resembled a cabinet of curiosities, the components of which stand in no recognisable relation to one another, or a miscellaneous collection of books placed in an orderly manner on shelves, but without any attempt at classification. As to the genesis of organic compounds, what would now be called absurd notions prevailed. I distinctly remember eminent chemists maintaining that no strictly speaking organic body, even of the simplest constitution, could possibly be formed without the intervention of the so-called vital force. The fact, then recently discovered by Wöhler, of the artificial formation of urea from inorganic substances, was considered as something almost miraculous,—*i.e.*, as a phenomenon the like of which would never again recur. Without, however, entering into further details, I think I may, without fear of contradiction, assert that the main distinction between the chemistry of fifty years ago and the chemistry of the present day consists in this, that, whereas formerly the science dealt chiefly with qualitative reactions, it now occupies itself principally with quantitative determinations. To have established the fact that every chemical phenomenon may be represented in figures, denoting either number, measure, or weight, such figures, when once accurately determined, remaining constant and unchanged through all time—this seems to me the crowning glory of modern chemistry. It is the firm establishment of this principle that has transformed the face of chemistry and has changed it from a mere descriptive into an exact science.

In justice to our predecessors it should, however, be remembered that this principle, though more fully developed in our own day, was not for the first time set up in quite recent times. The labours of Dalton, conducted on quantitative lines, were performed in this city of Manchester in the early part of this century. At the same time Berzelius was engaged in analysing the most important inorganic compounds and establishing the fact, not previously recognised, strange as it may now appear, that every well-defined substance has a definite chemical composition. But going still further back, we come to the alchemists. Now alchemy, if it has any logical basis at all, is founded on quantitative notions as regards matter. All metals, the alchemists said, consist of sulphur, salt, and mercury (these terms signifying not so much elements in the modern sense as qualities) in various proportions; hence their convertibility. Take copper, remove from it a certain proportion of its sulphurous constituent, and add more of the mercurial, and you have silver; repeat the process with silver, and gold results. At the time of which I speak, though much important analytical work had been done by Berzelius, Rose, and others in inorganic chemistry, though the veteran Chevreul had led the way in placing organic chemistry on a quantitative basis, and the composition of the most important organic compounds—thanks to the labours of Liebig and

* Read Thursday, September 1, 1887.

his method of organic analysis—had been ascertained, still quantitative determinations were not considered of such paramount importance as at present. In fact, scientific thought did not run in that direction, but satisfied itself, for the most part, with the study of qualitative reactions. It was still possible to see memoirs by eminent chemists containing not a single quantitative determination. Strange as it may seem, two able chemists, Boettger and Schoenbein, were living until quite recently who worked and obtained valuable results without resorting to the balance, the instrument which of all others seems the most indispensable to the chemist of to-day. The balance was indeed universally employed in my younger days, but no other instrument, properly so called, was ever seen in the laboratory. The spectroscope was not yet invented, the polariscope had not come into use; volumetric analysis was still in its infancy. Even the thermometer was but seldom used. What a different picture does the laboratory of the present day present, with its instruments of precision and its various appliances for effecting quantitative determinations of all kinds!

Whether the universal prevalence of and exclusive attention to quantitative methods in chemistry has been an unmixed good may be doubted. Who has not run with a weary eye over the long array of figures, the never-ending tables of which some modern memoirs seem to consist, and not longed for some mere description—were it only regarding trivial matters—to relieve the monotony and fix the subject treated of on the memory? That quantitative determinations given in quite precise terms may occasionally be entirely futile may be seen on referring to the history of alchemy. One of the later alchemists professes to have converted 5400 parts by weight of copper into 6552 parts of silver by the action of 1 part of a metal-improving substance (philosopher's stone).* Here we see the quantitative method applied to a purely chimerical process, elaborated from the depths of the experimenter's inner consciousness, and of no value whatever. Much of what is at the present day carefully worked out and presented to the world in numerical form may, like this statement of the alchemist, pass away and be forgotten. This may possibly be the case with the numerous carefully made analyses of water which we now meet with, and which we would gladly exchange for a few decided qualitative tests of its hygienic properties. In the case of air and water it is not the minuteness of the noxious matter which causes doubts to arise, but the absence of any decided and undoubted chemical characteristics of the impurities present. It is probable that a refined sense of taste, uncorrupted by the luxurious indulgences which civilisation has introduced, would be able to detect differences in drinking water which might escape the attention of the most consummate analyst.

Whatever objections may, however, be entertained to the application of quantitative methods in natural science, to the exclusion of others, it is certain that important results have flowed from their adoption, insomuch that we seem to have arrived at the conclusion that the expression of quantitative results is the be-all and end-all of science; that all differences are merely quantitative; that there is no such thing as mere quality. The whole philosophy of our age is expressed in this one proposition: All differences within the sphere of our experience are quantitative. It is the basis of Darwinism, if I am not mistaken, and underlies many of our political and social theories. Of course it is a mere assumption if stated generally, for the phenomena that admit of purely quantitative expression are few in number compared with those that do not; but then it is surmised, and with some degree of probability, that the vast region outside the quantitative sphere will in time come to be included within it. The past history of science seems to render this likely in the future. The science of chemistry has so far, however, presented an insuperable barrier to the general adoption of this view, and will continue to do so as long as the so-called elements remain what we now admit them to be—indestructible, immutable, inconvertible. It is possible to denote all the known properties of gold and silver, their atomic weight, specific gravity, hardness, malleability, action towards heat, light, and electricity in precise numbers with reference in each case to a certain standard, and yet we cannot say that silver, minus a little of this plus a little of that, constitutes gold—the two elements are essentially and radically distinct. Unless we admit with the alchemists that by taking away a little of A and adding a little of B we can convert one metal into another, one element into another, the quantitative method must fall short of its complete development in chemistry. Numerous attempts have therefore been made to show the theoretical probability, even if it should not be possible to prove it experimentally, of the so-called elements being really compound bodies, or at least of their containing a basic matter common to all. My predecessor in this chair has endeavoured to show, in the brilliant address delivered to this Section on the occasion of its last meeting, that the barrier hitherto presented to us by the intractability of our present elements may be overcome, and has adduced experimental illustrations in favour of his views of the compound nature of the elements. Mr. Crookes has called to his aid the doctrine of evolution, which has proved so valuable an instrument in the hands of the biologist, maintaining that the elements, like the species of plants and animals, were gradually evolved by some process of condensation from a primordial matter called by him protyle, each step in the process being represented by a distinct element. This is doubtless taking very safe ground, for if the process of evolution was the same in the inorganic as it is supposed to have been in the organic world, the process can never be repeated, and we shall therefore never be in a position to illustrate it experimentally. I may, however, have misunderstood what Mr. Crookes meant to convey, and, if so, must apologise for the dulness of my apprehension. Granting, however, the possibility of our resolving our present elements, were it in theory only, into modifications of one basic material out of which they have been evolved, the question would still remain to be answered, What has caused this primordial matter to be split up into groups and forms having distinct and opposite qualities? and when this question is answered, if it can be answered even in a problematical way, then other questions would arise, until by degrees we should arrive at the confines of physical knowledge and find ourselves in the region of metaphysics, where scientific reasoning ceases and thinking for scientific purposes becomes unprofitable. Excursions into this region would indeed be very useful if on returning to physical regions we could every time bring back with us an instrument as potent and far-reaching as the atomic theory has proved to be, a theory which still remains the basis of all our reasoning in chemistry; but then the atomic theory has been quite an exceptional instance. Metaphysical speculation, such as the Naturphilosophie of the Germans has dealt in, has, generally speaking, been utterly barren in natural science.

I will not on the present occasion dwell on the vast addition made to the number of useful and beautiful substances by chemists during the last fifty years. Their number is legion, and their mere description fills volumes, whereas half a century ago a dictionary of moderate size would have sufficed for the purpose. Among these newly discovered substances none are more remarkable than the metals rubidium, cæsium, thallium, indium, gallium, the existence of which was revealed by the spectroscope, and which, indeed, would have probably remained unknown but for the labours of Bunsen and Kirchoff in perfecting and applying that instrument.

I must not, however, omit all reference to a department of chemistry which has been, one may almost say, created within the time to which I am referring—I mean that of synthesis. When I began to study chemistry we only

* Kopp, *Die Alchemie.*

heard of analysis; of synthesis, so far at least as regards organic bodies, we only dreamt as a remote and unattainable region. The only instance then known of the synthesis of an organic substance was that of urea by Wöhler. Synthesis was, indeed, supposed to be an essentially vital process effected under the influence of the vital force, and quite outside the sphere of the chemist. Since then what marvels have we not seen? Alizarin and purpurin, the colouring-matters of madder, have been prepared artificially by Graebe and Liebermann, indigo by Baeyer, not to mention bodies of simpler constitution obtained by comparatively less complicated processes. We are honoured to-day by the presence of Professor Ladenburg, who has succeeded in artificially preparing coniin, the alkaloid to which hemlock owes its poisonous properties,—the first natural alkaloid, indeed, which has been obtained artificially. Looking back at what has been achieved I think we may entertain the confident anticipation that all the most important organic bodies, acids, alkaloids, and neutral substances will, in course of time, be obtained in a similar manner, though of one thing we may be pretty sure, viz., that we shall never succeed in forming any really organised matter as distinct from organic. The term organic matter is in fact only employed for the sake of convenience, and as an expression handed down to us from former days, since so-called organic compounds are subject to the same laws with regard to composition as the bodies which we name mineral or inorganic, but organised matter such as we find constituting the vessels of plants and animals is a different thing. The protoplasm contained in the vegetable and animal cell is something very distinct from the same matter after the death of the organism, but the difference between living and dead matter is not of a chemical nature. In referring to chemical synthesis I cannot refrain from expressing regret that so little has hitherto been done in the artificial production of minerals with a view to elucidating the processes by which they were formed in nature, but it is possible that more has been done in this direction than I am aware of, since this is a department of chemistry with which I am not familiar. It is certain that inorganic chemistry generally does not now receive the attention which it formerly did. The exclusive devotion to the chemistry of the carbon compounds which we find in most of our laboratories at the present day may, however, be accounted for when we see the brilliant results to which the study of those compounds has led.

After these few remarks on the development of chemistry during the last fifty years, of which I know a little, it may seem presumptuous on my part in the presence of some of the most eminent chemists of our day, whose opinions must be of infinitely more value than mine, to say anything about the future of our science and the direction it will probably take. Nevertheless, trusting to your kind indulgence, I will venture on some speculations in this direction, which, if they do not instruct the younger members of the Section, may serve to amuse their seniors, and at all events will refer to subjects on which some thought is well bestowed.

As regards the future of chemistry, the question has frequently suggested itself to me as it has doubtless done to others—Will chemical science go on expanding and developing during the next few generations as it has done in the course of the last hundred years? Will discovery follow discovery, and fact be added to fact, until the record occupies not a few volumes only, but a whole library? Will systematic chemistry, *i.e.* the history and description of all possible combinations of the elements, have any limits? I am inclined to answer in the negative. All human institutions pass through the same phases; they have their rise, they culminate, and decay; and I do not see why the science of chemistry should form an exception. Moreover, it is a natural law that whatever develops rapidly also declines rapidly, and the development of systematic chemistry since the commencement of this century has been perfectly unprecedented. I think it probable that in the course of time, at the rate at which we are now progressing, nearly all possible compounds will have been prepared, all the most important chemical facts will have been discovered, and pure chemistry will then be practically exhausted, and will be in the same condition as systematic botany and mineralogy now are. New compounds will now and then be discovered, just as new plants and new minerals now are, but nothing further will be brought to light that will affect the theories at which we shall then have arrived, whatever they may be. All the material with which the science has to deal having then been brought together, what will happen? Will chemical science cease? Will chemists, satisfied with past achievements, cease to work, confining themselves to practical questions and the history of the days gone by? I think not. The science will continue to develop, but it will be in other directions than those previously pursued. The exhaustion of systematic botany has not put an end to botanical science, for vegetable physiology has opened a wide field to the botanist, one that will take a long time to explore thoroughly. To indicate the directions which chemical science will take in its various applications to other departments of knowledge, as, for instance, in connection with the study of the physical properties of matter, or in elucidation of the chemical processes whereby minerals have been formed, or those through which geological strata have passed in by-gone ages, would not be within my competency, as I should have to touch on subjects with which I am not familiar; but I may be permitted to refer by a few words to a subject, with which, by reading at least, I have become better acquainted, and which seems to me to offer a wide field to the investigator who shall come well provided with physical and chemical knowledge to its cultivation. I allude to the processes whereby the substances constituting the various organs of plants and their contents are formed, and those again to which the decomposition and decay of vegetable matter are due; a subject as to which our knowledge is quite elementary, but which, it seems to me, admits of an extension and development of which we have at present not the least conception.

De Saussure, it is well known, first discovered the fact that plants under the influence of light absorb carbonic acid and give off oxygen, the inference of course being that the carbonic acid and the water present are decomposed, the carbon of the former and the hydrogen of the latter going to form the various organic constituents of the plant, while the oxygen or a part of it is set at liberty and poured into the atmosphere. The facts as they stand are simply these: what the plant requires for its subsistence is carbonic acid, water, nitrogen in some form (presumably that of a nitrate), certain bases—potash, lime, magnesia, iron oxide, and phosphoric acid. Out of these it constructs the whole of its organic frame, its cells and their contents, re-arranging the elements of which its food consists in such a manner as to convert inorganic into organic matter, *i.e.* changing bodies in which the affinities of the atoms are thoroughly satisfied into such as contain them in a state of more or less unstable equilibrium, and therefore liable to alteration when their atoms are allowed to act in accordance with their natural affinities. More than this we do not know; our ignorance of the several steps or stages of the process, if there are any such steps, is complete; all that has been added to the general statement just given is mere speculation. Yet it is impossible to remain satisfied with the present state of our knowledge on the subject. Accordingly numerous attempts have been made to bridge over the chasm which separates the inorganic and organic worlds, not indeed to show that the change does not involve the creation, as was once supposed, of new matter—for this was proved long ago—but to exhibit in its details the hidden mechanism which produces it, but hitherto without success. We know that light is essential to the process of assimilation in plants, since this does not proceed in

he dark, but this fact does not help us to an explanation, or light in this case is a mere stimulant, and never produces the same or similar effects outside the vegetable organism. Liebig and others have attempted to show that the process of assimilation in plants commences with the formation of some simply constituted body, such as oxalic or formic acid, with the elimination of oxygen, out of which by condensation and further separation of oxygen more complex bodies, such as sugar, fats, &c., are formed; but there is not the slightest evidence at present in favour of this view. The first product of assimilation that is directly recognised is starch, a highly complex organic, we might also say an organised body, which appears at once with all its characteristic properties, like Minerva springing fully armed from the head of Jove. If we are to adhere to the facts so far observed, we must conclude that the plant does not proceed as we should do in the laboratory, beginning with the more simply constituted compounds and advancing to the more complicated, but that the reverse process is the one actually adopted, the supposed intermediate products being more probably the results of retrogressive metamorphosis. This conclusion is, however, so much opposed to ordinary chemical views that one cannot feel surprised at the constantly repeated attempts to clear up the question. There can be no doubt indeed that much here remains to be done and to be discovered.

Intimately connected with this subject is that of chlorophyll, the green colouring-matter of leaves, which is always found wherever the process of assimilation in plants is going on, and nowhere else, and is therefore doubtless an essential factor in the process. What part it plays in this process is, in my opinion, still unknown. Its action is probably in part chemical, in part physical, and this adds, it may be, to the difficulty of understanding it. It is generally supposed that it is chlorophyll which by its direct action on the carbonic acid and water with which it comes in contact leads to the formation of organic matter with elimination of oxygen. But this is, I think, a mere assumption—an error due, like many others, to a mistaken use of terms. The chlorophyll of chemists is simply an organic colouring-matter, like alizarin or indigo, but being in the vegetable cell intimately associated with other matters, vegetable physiologists have attributed to the action of one, and that the most obvious, constituent what is really due to the complex, perhaps even to some quite other constituent of the complex. It is impossible to conceive that the chlorophyll of chemists can be endowed with the remarkable and exceptional properties attributed to it by physiologists; it is a chemical entity, nothing more. It may indeed be said that chlorophyll only acts as it is stated to do when enclosed within the vegetable cell, but this merely amounts to saying that its action is not purely chemical, but is controlled by the vitality of the cell, which, I suppose, means the action of the protoplasm. If chlorophyll is the agent whereby the decomposition of carbonic acid and water is effected, how, it may be asked, is the agent itself produced? It does not come from without; the plant must be able to form it in the first instance. We are told by vegetable physiologists that the coniferæ when raised in total darkness from seeds produce chlorophyll. In light or in darkness I am convinced it is the same; the plant forms chlorophyll as a means to an end. What the end is we know; it is the assimilation of carbon and hydrogen to form organic matter. How does the chlorophyll assist in attaining this end?

In propounding a new theory in reply to this question I venture to claim your indulgence, such as has been accorded to some of my predecessors and others who at these meetings of the British Association have been permitted to make statements and use arguments of a novel or paradoxical character, which, if they effect nothing else, at least afford a relief to the usual routine of scientific reasoning. My experiments on chlorophyll have led me to infer that the constitution of that body is much less simple than it is generally supposed to be. I do not mean by this that chlorophyll is a mixture in the usual sense; everyone who has paid any attention to the subject knows that ordinary chlorophyll consists of several colouring-matters, some of which are yellow, not to mention fatty matters which are unessential. What I mean to say is this, that the pure green substance, the chlorophyll *par excellence*, does not belong to the same class of bodies as alizarin or indigo, but contains three elements, each of which is essential to its constitution, one being a basic nitrogenous colouring-matter, the second a metal or a metallic oxide, the third an acid, the three together constituting green chlorophyll. The basic colouring-matter is a body of very peculiar properties; it is the phyllocyanin of Fremy: the metal may be iron or zinc, the acid I will suppose to be carbonic acid. Now the plant having formed its colouring-matter, the metallic oxide being present in some form or other, and the carbonic acid being supplied by the atmosphere, all the necessary conditions co-exist for the formation of chlorophyll. The compound is an unstable one; it easily parts with its carbonic acid, giving it up to the protoplasm or whatever the agent may be that effects its actual decomposition under the influence of light. The advantage of this arrangement would consist in this, that the carbonic acid would be presented in a more condensed state to the agent which effects its decomposition than if it were merely contained in a watery solution, but more loosely combined, and therefore more easily accessible than if it were united to a strong base such as potash or lime. The carbonic acid having been disposed of, the other two constituents would be in a state to take up fresh quantities of carbonic acid and so on. Chlorophyll would therefore act as a carrier of carbonic acid in the plant, just as hæmoglobin serves to convey oxygen in the animal economy. Numerous objections may of course be raised to the theory of which I give an outline; I only throw it out as a tentative explanation, showing that the function of chlorophyll may be, in part at least, chemical, and that we need not suppose it to be endowed with the marvellous and exceptional powers usually ascribed to it. Other and more probable explanations will doubtless suggest themselves when this difficult subject has been more thoroughly worked out. Eventually, too, it will be found, I imagine, that physical forces as well as chemical affinities play a part in this as in every other process of the vegetable economy. In the case of chlorophyll there can be no doubt that the green colour and the peculiar behaviour towards light have something to do with its action, but on this point it is not necessary for the chemist to pronounce any opinion. I may take this opportunity of mentioning the important experiments of Sachs and Pringsheim on the optical properties of chlorophyll in their relation to assimilation in plants, as they are probably not so well known to chemists as to botanists.

What I have said may serve to show that the very first steps of the process whereby organic or organised matter is formed in plants are hardly understood. We understand still less the further steps leading to the production of the more complex vegetable bodies—acids, alkaloids, fatty matters. Granted that we were able to trace the formation in the plant of a compound of simple constitution, such as oxalic or formic acid, how far should we still be from understanding the building up of such compounds as starch, albumen, or morphia? The syntheses so successfully and ingeniously carried out in our laboratories do not here assist us in the least. We know the steps by which alizarin is artificially produced from anthracene; but can anyone for an instant suppose that the plant commences in the same way with anthracene, converting this into anthraquinone, and having acted on the latter first with acid, then with alkali, arrives at last at alizarin? Indeed the plant never contains ready-formed alizarin at all. What we observe from the commencement is a glucoside, a compound of alizarin and glucose, which, so far as we see, is not gradually built up,

but springs into existence at once. When we think of the complicated process by which indigo is produced in the laboratory with the various substances and appliances required, and then see how in the minutest seed-leaves of a plant like woad a still more complex substance, indican, is found ready-formed, we stand confounded at the simplicity of the apparatus employed by the plant, and are obliged to confess that we have no conception of the means whereby the end is attained. The same difficulties occur in other cases, and it will therefore probably be conceded that the synthetic processes carried on in plants, from the first step to the last, are not in the least understood.

It might be supposed that after all the labour and attention bestowed on the inorganic constituents of plants we should know something of the part played by these constituents in the processes of assimilation and nutrition, but here the obscurity is as great as elsewhere. We know by experiment that certain inorganic matters—potash, lime, magnesia, iron oxide, phosphoric acid—are essential to the growth of plants; but of their mode of action, or of the reason why certain plants require potash salts, others lime, and so on, we know nothing. Phosphoric acid is no doubt an essential constituent of the protoplasm of the plant; but why cellulose, of which the various organs chiefly consist, should require mineral matters, which do not enter into its composition, for its formation and building up is still a mystery.

The department of chemistry which relates to the decomposition of organic and organised matters presents problems almost as difficult of solution as those relating to their formation and building up; that is to say, the phenomena observed do not apparently obey the same laws as those prevailing in the inorganic world. When I began my chemical studies the difference in this respect between mineral and organic compounds was less clearly seen than at present. The conversion of alcohol into acetic acid, the putrefaction of animal and vegetable matter were thought to be simply due to oxidation; they were phenomena, it was supposed, exactly similar to the rusting of iron, the tarnishing of metals, the fading of colours. That a third body was required to initiate and continue the process of decomposition, that organic matter in contact with purified air would remain unchanged for any length of time—was not known nor suspected. I am not quite sure whether spontaneous decomposition—*i.e.* the splitting up of a complex body without the intervention of an external agent—might not at that time have been considered possible. In order to explain the phenomena of fermentation, the decomposition of sugar into alcohol and carbonic acid, for instance, we had only the theory of contact—devised by Berzelius and Mitscherlich, the latter of whom used to expatiate on the subject at great length in his lectures. When this ghost of a theory was laid by Liebig, who suggested an intelligible explanation of the phenomena in accordance with the facts then known, it was felt to be quite a relief, as affording a resting-place—if only a temporary one—for the mind. The brilliant researches of Pasteur, which have thrown so much light on the action of the insoluble organised ferments, I need only refer to, as they are so widely known, even outside scientific circles; and since also investigations such as his cannot be discussed without some reference to biological questions, which cannot be entered on now. I will confine myself therefore to a few remarks on the unorganised or soluble ferments, one of which I had occasion to examine when engaged in investigating madder and its colouring-matters. These ferments, the type of which is diastase—a substance found accompanying starch in the seeds of plants—are soluble in water, perfectly neutral, devoid of all definite form, and though apparently inert, able when acting within the sphere in which Nature has placed them, to cause changes and decomposition of the most profound character. Their action excludes everything in the shape of vitality, and yet it is as mysterious and unaccountable as anything that the vitality of the organised ferments is capable of effecting. Indeed, in vegetable, and especially animal, organisms they seem expressly intended for the attainment of certain ends necessary for the well-being, or even the existence, of the organism, insomuch that it has been supposed, with some show of reason, that it is to bodies of this class existing within the cells of organised ferments, but not separable by any means at our disposal, that the changes produced by the latter are really due.

A great deal of attention has been paid to the products and results of fermentation, but very little hitherto to the *modus operandi* of the ferments themselves, and yet this seems to me to offer a wide field for interesting research, especially in the case of those of the soluble class, which are easily prepared, and can be manipulated in the laboratory like any chemical substance without the tedious precautions and preliminary operations necessary in the case of the organised ferments. In what way, it may be asked, do these soluble ferments produce the effects peculiar to them? Is the action essentially chemical, or is it due to physical causes as well? Is the quantity of fermentable matter acted on by a certain quantity of ferment unlimited in amount, or are there limits to that amount somewhere? Does the ferment itself undergo any change during the process of fermentation, or is it the same afterwards as before and capable of acting on fresh quantities of fermentable matter? When a ferment is replaced by a strong mineral acid, the products of decomposition being the same, is the *modus operandi* in both cases alike, or must a different explanation be in each case sought? These questions have never been satisfactorily answered, and await solution. I know of only one attempt to show what actually takes place during a process of fermentation set up by a soluble ferment.

The experiments of Wurtz* on papaïn, the soluble ferment of *Carica papaya*, led to the conclusion that the fibrin on which it is made to act combines in the first instance with the ferment itself, the latter after the hydration of the fibrin is completed being again set at liberty, and then able to act on fresh quantities of fibrin. Thus, according to Wurtz, the action is found to be the same as that of chemical agents, properly so called, such as sulphuric acid, of which minute quantities may exert a hydrating action in consequence of the transitory formation of compounds which are constantly being produced and again decomposed.

There is another question referring to these soluble ferments to which in the present state of our knowledge it is impossible to frame a probable answer, viz., why does it so frequently happen that each ferment exerts a specific action, an action peculiar to itself, this being in fact, in the absence of any marked chemical characters, the only means by which they can be distinguished one from the other? Why does one ferment act on starch only, while the function of another consists in the hydration of fibrin, that of another in the decomposition of a glucoside, and so on? In accordance with the explanation of Wurtz, we should say that a specific ferment is one capable of combining only with the body on which it is to act, and with no other. I was led to ask this question when engaged in the examination of the colouring matters of *Rubia tinctorum*. The root of this plant, the madder of commerce, contains glucosides, which, though coloured, are quite devoid of tinctorial power. Nature has at the same time placed in the root a peculiar ferment, which, coming into contact with these glucosides at a certain temperature, effects their decomposition, splitting them up into glucose and true colouring matters. Now this ferment is a body *sui generis* and cannot be replaced by any other ferment that I have tried; its action is specific. Why Nature should have deposited this body in the recesses of the plant for the express purpose of acting on certain glucosides and forming colouring matters, the object of which, so far as

* *Comptes Rendus*, 91, 787.

the economy of the plant is concerned, can only be guessed at, is difficult to understand. One is inclined in such a case to revert to the old-fashioned doctrine that some natural processes were devised for the use and delectation of man. It is quite certain in the case of madder that had it not been for its peculiar ferment erythrozym, the valuable tinctorial properties of the root, which have for centuries been applied in the production of that splendid dye Turkey red, would have remained unknown perhaps to the present day, since the only efficient substitute for the natural ferment is a strong mineral acid, and such acids and their uses were unknown in former days.

I am inclined to think that some of the younger chemists and physiologists of to-day may live to see the time when all the at present mysterious and unaccountable processes going on in the organisms of plants and animals, including those of fermentation, will be found to obey purely physical and chemical laws. To the biologist it may seem derogatory to the dignity of his science to have the principle of vitality, which has so long reigned supreme, dethroned and replaced by hard, unbending law. Such, however, is not the opinion of that distinguished botanist Sachs, who says, referring to this very point:—"Der Organismus selbst ist nur die aus verschiedenen Theilen bestehende Maschine, die durch weitere Eingriffe äusserer Kräfte in Bewegung gesetzt werden muss: von ihrer Struktur hängt es ab, welchen Effekt diese äusseren Kräfte an ihr bewirken. Es würde einen sehr niedrigen Horizont wissenschaftlicher Bildung verrathen, in diesem Vergleich eine Herabsetzung des Organismus sehen zu wollen, denn in einer Maschine, wenn auch nur von Menschenhänden gemacht, leigt das Resultat tiefsten und sorgfältigsten Nachdenkens und hoher Intelligenz, soweit es ihre Struktur betrifft, und wirksam sind in ihr schliesslich dieselben Naturkräfte, welche in anderer Combination die Lebenskräfte eines Organs darstellen. Die Vergleichung des organischen Lebens mit unorganischen Processen kann nur dann als eine Erniedrigung des ersteren gelten, wenn man so thöricht gewesen ist, die letzteren als etwas Niedriges und Gemeines aufzufassen, während die unbegreifliche Grösse und Durchgeistigung der Natur in beiden Fällen sich gleichartig offenbart."* The time may be far distant when these views of the great botanist shall be universally accepted; but they will, I think, sooner or later prevail.

The little known territory which separates the domains of chemistry and physiology will, in my opinion, offer a wide and interesting field for research, after that of pure chemistry shall have been exhausted or lost its interest. Most important problems connected with life and its relation to the inorganic world there await solution, and I confess that I am inclined to envy the young investigator who, coming provided with an ample store of chemical and physical knowledge, shall apply himself to the solution of these problems. The pleasures derived from the successful pursuit of such studies belong to the highest and purest that we are able to conceive. I can, however, only repeat what has so often been said before, and what the young man of science should not forget, that a life devoted to research only involves no material rewards; it certainly never secures wealth, sometimes not even honour nor fame. Looked on with indifference or even dislike by the State, the Church, and the public at large, all that the man of science can certainly look forward to at the close of his career is the addition at his hands of a few stones to the vast edifice of truth, and the consciousness of having attained a higher stage of intellectual insight.

You may probably expect me, before I conclude, to make some reference to technological matters, to the various chemical arts and manufactures for which the Manchester district is noted. At the last meeting of the British Association in Manchester a report on the condition at that time of manufacturing chemistry in the South Lancashire district, by Sir Henry Roscoe, the late Dr. Angus Smith, and myself, was laid before the Chemical Section. A similar report showing the progress made in chemical technology since that time would have been interesting. Great changes have taken place during the period that has elapsed, especially as regards the alkali trade, and quite a new branch of industry has been developed, that of the coal-tar colours. A description of these new features of our chemical industry with statistics of production would therefore have been acceptable. The idea of a report had however to be given up on account of the difficulty of obtaining reliable information as to details, and in these matters it is the details only which are interesting, the general features of the subject being well known. It can hardly be a matter for surprise, I think, that our manufacturers, considering the active competition to which they are exposed, and the disadvantages under which they labour in consequence of the exclusiveness of foreign nations, should be loth to furnish information which would benefit their rivals in trade. Several interesting papers on branches of chemical industry by gentlemen well versed in them will, however, be read before the Section, and these will, to a great extent, make up for the want of a general report. In the Chemical Section of our Jubilee Exhibition, too, you will see a very fine collection of chemical products, more extensive and beautiful, perhaps, than any previously brought together, and these will give you a good idea of our industrial activity. It would have been interesting to witness step by step some of the processes employed in the manufacture of these various products, but this, I am sorry to say, must not be expected generally.

To some it may seem that this Jubilee Exhibition shows the manufacturing industry and prosperity of this district at least at their highest state of development; that they are now at their meridian, and in the future are doomed to decline. If this be so—and there are certainly indications which seem to favour this view—it would be well for those whose visits here are only occasional to take especial note of the present state of things so as to be able to compare their impressions when they next visit us with those now received, since gradual changes in communities, as in individuals, are more patent to casual observers than to those who are always on the watch.

From some points of view the signs of the times are certainly not encouraging. It should not be forgotten that the manufacturing prosperity of this district depends to a great extent on the ample supply of a product which is brought to us at some cost from tropical and semi-tropical countries to be re-exported in the shape of manufactured goods. A political convulsion abroad, and this, unfortunately, is a casualty that may at any time be expected, or even the determination on the part of other nations to starve us out, however short-sighted such a determination might be, might cut off our supplies and disable us permanently as we were partially disabled twenty-five years ago. If to this be added the fact that foreign nations are becoming increasingly hostile and exclusive commercially, we cannot feel surprise at the dismal forebodings entertained and the confident predictions of decline uttered by some who claim to know all the facts. I ought to apologise for alluding to so gloomy a subject on the occasion of this to a great extent festive gathering, but then men of science like to look at a question not only from a hopeful but from every point of view. Fortunately on this question they are not called upon to pronounce any opinion one way or the other.

Should this be the last time that Manchester shall entertain the British Association in the day of its prosperity, I can only say with the German poet—

> Schliesst den Kreis und leert die Flaschen
> Diese Sommernächte feiernd,
> Schlimme Zeiten werden kommen,
> Die wir Auch sodann ertragen.

Whether in prosperity or adversity I feel sure that this city will always endeavour to entertain its visitors to the

* *Vorlesungen über Pflanzenphysiologie.*

best of its ability. On the present occasion I may with confidence on the part of the chemical world of Manchester offer to the many friends from near and far who honour us with their presence at this meeting a most hearty welcome.

WATER ANALYSIS.

At the meeting of the American Association for the Advancement of Science, held at New York in August last, a previously appointed Committee of Section C presented their recommendations on a plan for a uniform method of stating the results of Water Analysis.

The report was accepted and the Committee was reappointed. Two members of the Committee—Professors Langley and Clarke—attended the late meeting of the British Association, and have been the means of securing the appointment of a Committee of Section B to cooperate with the Committee of American chemists. The following is the report of the American Committee:—

"Your Committee are of the opinion that one scale for both mineral and potable waters is unadvisable: the scale that would be desirable in order to avoid the use of too large numbers in stating the composition of a mineral water would necessitate the use of inconveniently small decimals in the statement of the composition of a potable water, or one examined for sanitary purposes.

"The Committee therefore recommend the adoption of two schemes, as follows:—

I.

"*Scheme for a Mineral Water.*

"*a.* That the composition be expressed in parts per thousand, by weight.

"*b.* That the parts per thousand of each basic element, K, Na, Li, Ca, Mg, Fe^{II}, (Fe_2^{IV}), &c., be given, and of each acidic element, Cl, S, I, &c., that is combined directly with a basic element or that may reasonably be supposed to be so combined: the rest of the acidic elements to be given in connection with all the oxygen of their salts as usually written in our present empirical formulas, as CO_3, SO_4, PO_4, &c.

"*c.* That these constituents be arranged in electrochemical order, the positive ones being given first.

"*d.* That the volume of O, CO_2, and of H_2S expelled on boiling be given in cubic centimetres per litre of water.

"*e.* That the combination deemed most appropriate by the chemist making the analysis be stated, both by names and by symbols.

II.

"*Scheme for a Water Examined for Sanitary Purposes.*

"The composition shall be expressed in parts per million (milligrammes per litre) as illustrated below:—

Total solids	
Chlorine	
Nitrogen expelled on boiling with Na_2CO_3	
,, equals 'free ammonia'	
,, expelled in boiling with alkaline $KMnO_4$	
,, equals albumenoid ammonia	
,, as nitrite	
,, as nitrate	
Organic matter (expressed in terms of milligrammes of O consumed by one million of the water)	
Hardness	

"The manner of expressing the results on organic matter must depend somewhat upon the method of its estimation.

"The scheme for mineral waters is, in its essential or non-important general features, the same as that recommended by a Committee of the Washington Chemical Society in a Report to that Society, and which was made the subject of a Paper read before Section C at the Buffalo meeting of the A.A.A.S."

ON THE ANALYSIS AND PROPERTIES OF PHOSPHORISED SILVER.

By H. N. WARREN, Research Analyst.

During the reduction of argentic phosphate by means of charcoal, and using calcium borate as a flux, on examination of the reduced metal it was observed to possess a decided yellow tint, resembling in every respect silver containing about 25 per cent of gold, and at the same time retaining a perfect malleability similar to pure silver, although after fusion refusing to spit on cooling. On submitting the same to a careful gravimetric analysis the mean of several estimations were as follows:—

Silver	95·42
Sulphide of silver	4·30
Gold	0·38
Phosphorus	traces
	100·10

The sulphide of silver present apparently becoming introduced on account of the calcium borate used to flux the metal containing calcium sulphate, which, on being subjected to a high temperature, becomes partially reduced by means of the charcoal. The sulphide of silver existing in the regulus, however, apparently played no part in transmitting a yellow colour to the silver, which was afterwards confirmed by taking pure silver, and introducing phosphorus in small pieces when in a fluid state; the silver, on cooling, apparently throwing off the whole of the phosphorus in the form of small jets, which burnt lively on the surface of the metal, the silver at the same time, however, retaining sufficient phosphorus to prevent its spitting on cooling and to produce a decided yellow tint, although the average result as regards the percentage of phosphorus in the same seldom exceeded 0·002 per cent: this quantity of phosphorus, although so minute, is exceedingly difficult to expel by means of cupellation, often requiring from three to four consecutive cupellations with lead before leaving the silver possessed of its natural properties.

RELATIONS OF MERCURY TO OTHER METALS.

By A. C. COUSINS.

Since my first paper on mercury, I have noticed other relations between that metal, gold, and thallium, which are interesting, and if not accidental may possibly lead to the discovery of an important law.

The atomic weights and specific gravities are those previously given, and are the most recent determinations I have been able to obtain:—

	Sp. gr.	Atomic Weight.	Atomic Volume.
Gold	19·263	196·2	10·181
Thallium	11·86	203 6	17·167
Mercury, liquid	13·598	200·0	14·708
,, solid	14·39		

It will be seen that not only is the atomic weight of mercury the mean of that of gold and thallium, but its specific gravity in the liquid state is very nearly the mean of their atomic volumes; and its own atomic volume is

almost exactly the theoretical specific gravity of an alloy formed of equal weights of gold and thallium, the calculated specific gravity being 14·68, which is only 0·29 in excess of the specific gravity of solid mercury.—*Oil, Paint, and Drug Reporter.*

NOTICES OF BOOKS.

Physico-Chemical Constants. Melting- and Boiling-Point Tables. By Thomas Carnelley, D.Sc. (London), B.Sc. (Vict.), F.C.S., F.I.C. Vol. II. London: Harrison and Sons.

This second volume of Tables of Melting- and Boiling-Points completes—as the author tells us, and as we can well believe—a labour of ten years. It contains upwards of 32,000 melting- and boiling-points, making up, with those given in Vol. I., a total of over 51,000.

The arrangement adopted is that of compounds containing respectively four, five, six, seven, and eight elements; those containing special elements. Each page gives in parallel columns first the name of the compound in question, then its constitution, its formula, boiling-point, melting-point, the authority for the determinations, reference to the Journals or Transactions where the Memoirs originally appeared, and a further reference to "Watts's Dictionary" and to the *Journal of the Chemical Society*.

The third part comprises tables of the vapour-tensions and boiling-points of simple substances; corresponding tables for mixed liquids and saline solutions; freezing and melting-points of mixtures, including cryohydrates; miscellaneous melting- and boiling-point data, such as melting- and boiling-points of fats and oils. Lastly follow the volumes and corresponding years of issue of the more important chemical and physical periodicals, and an alphabetical index of root carbon compounds.

It would be difficult to name a more meritorious and a more *self-denying* work than the one before us,—one that for so many years of labour will return the author so little in the way of *kudos*. Not alone the general public will take no notice of the book, but even physicists and chemists—to whom it will save frequent trouble and expenditure of time—will, we fear, feel little gratitude to the author. The more honour, therefore, is due to Dr. Carnelley on the part of all who have the welfare of Science really at heart.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 5, August 1, 1887.

On Thorium Silicates.—L. Troost and L. Ouvrard.—The authors have previously shown that the study of the double phosphates formed by thorium and zirconium with phosphoric acid and potassium or sodium furnishes no argument for approximating thoria and zirconia. The study of the combinations of thoria with silica shows us a compound in which this base seems to deviate still more widely from zirconia. The composition and the crystalline form of thorium silicate tend to remove this base from zirconia just as the composition and the crystalline form of thorium metaphosphate remove it from silica, to which it had been formerly approximated.

New Fluorescences with Well-defined Spectral Rays.—Lecoq de Boisbaudran.—Alumina, containing 1-1200th of samaria, after powerful ignition with the gas-blowpipe, give a very fine orange fluorescence, which is still more brilliant with 1-50th of samaria. The effect of the previous application of a very high temperature upon chromiferous alumina and samariferous alumina is the same. There is an enormous increase of lustre, the production of narrow rays, and a transfer of the maximum illumination towards the red.

Fluorescence of Spinel.—Lecoq de Boisbaudran.—The author maintains that the red fluorescence of spinels is due to chrome, and their green fluorescence to the presence of manganese.

Spectra of Didymium and Samarium.—Eug. Demarçay.—The author has observed among among the products of the fractionation of praseodymium the band $\lambda=469$ (of equal strength to $\lambda=444$) with very different intensities, and concluded hence that $\lambda = 469$ did not belong to praseodymium. On further fractionation he confirms his former observation, but not the conclusion which he drew. We see in the fractions which no longer give a trace of the band $\lambda=444$ characteristic of praseodymium a narrow band $\lambda = 469{\cdot}8$, well-defined and resembling the ray 427·5 of didymium. This band therefore does not belong to praseodymium. On the other hand in the purest portions of praseodymium containing merely a little lanthanum, we observe a very strong but nebulous and diffused band about $\lambda = 469$ of an aspect very different from the foregoing. We must therefore conclude that these bands have a similar wave-length, but are distinct from each other, the former belonging to a body still unknown. In portions of neodymium pure from praseodymium and containing only little samarium, there are found some rays not yet described: (1) $\lambda=464$ about, a very narrow ray at the more refrangible margin of the corresponding nebulous ray of didymium; (2) $\lambda=430$, a narrow and rather faint ray. M. Soret has mentioned a doubtful ray about this place; (3) $\lambda=476$ about, of the spectrum of didymium appears in a nitric solution formed of a strong double ray, of which the more refrangible component is the more intense. The author maintains that in *Comptes Rendus*, cii., p. 1551, and civ., p. 580, he has anticipated the discovery of Krüss and Nilson that samarium consists of at least two simple bodies.

Formation-Heat of Certain Crystalline Tellurides.—Ch. Fabre.—The author concludes that in one and the same family as the equivalent weight of a non-metal combined with a metal increases the quantity of heat liberated on combination declines.

Succinimido-acetic and Camphorimido-acetic Ethers.—A. Haller and G. Arth.—This paper does not admit of useful abstraction.

A New Isomer of Benzene.—G. Griner.—This compound is a solid which melts at 64° and distils about 129° to 130°. It plays the part of a non-saturated body. If dissolved in carbon disulphide it fixes in the cold 4Br.

Remarks on the Observations presented by M. Grawitz on the Preparation of Aniline Chromates and their Applications.—Ch. Girard and L. L'Hote.—No one before the authors had isolated and studied aniline dichromate, a crystalline salt of which they have given the formula and the chemical properties. This bichromate in a state of purity, contrary to the pretensions of M. Grawitz, can be isolated only on operating with an acid solution of an aniline salt.

On a New Microbe, determining the Indigotic Fermentation and the Formation of Indigo Blue.—E. Alvarez.—The author concludes that indigo is a fermentation-product. This formation is determined by a special micro-organism, which is a capsuled rod having the greatest resemblance to those of pneumonia and rhinoscleroma, which latter equally give rise to the indigotic fermentation. The indigo bacillus has pathogenous properties, and may occasion in the animal system either

a transient local inflammation or rapid death with visceral congestion and fibrinous exudations.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série, Vol. ii., No. 17, May, 1887.

Report presented by E. P. Bérard on behalf of the Committee of the Chemical Arts on the Cryptographic Procedures of Prof. Schlumberger.—The object of the invention is to furnish proof of the genuine character of share-certificates and bonds, and to prevent alterations in the figures of cheques.

Wines and Brandies from Raspberries and Strawberries.—A. Rommier.—From the *Comptes Rendus.*

The Sugaring of Musts and the Manufacture of Sugar Wines.—MM. Klein and Fréchou.—From the *Comptes Rendus.*

No. 18, June, 1887.

Report presented by M. Biver on a System of Melting Furnaces for Glass Works with Recovery of Heat, devised by M. Charneau.—This paper requires the accompanying figures, which have been placed by mistake in No. 17.

Revue Universelle des Mines, de la Metallurgie, &c., Vol. xxi., No. 2, March and April, 1887.

Aluminium and its Alloys; the Processes of H. and A. Cowles and Dr. Mabery.—R. Van Langhenhove.—The author points out the superiority of aluminium bronze over common bronze and steel for the manufacture of artillery. Its higher price is more than compensated by its lightness and its greater resistance, which is about triple that of ordinary bronze.

MISCELLANEOUS.

City and Guilds of London Institute.—Technological Examinations.—The following is a summary of the mor mportant alterations and additions which have been introduced into the Programme of Technological Examinations for the year 1887-8, and of other matters to which the attention of Teachers and Secretaries is especially directed:—1. The grant made to teachers on account of students who are awarded the Full Technological Certificate in the Honours Grade of any subject is £3 for a 1st class and £2 for a 2nd class certificate. 2. The examination in subject 29, Carriage Building, will consist of two parts. Section I. will be devoted to Road Carriages, and Section II. to Rail Carriages. 3. The syllabus of subject 16 B, Boot and Shoe Manufacture, has been reconstructed with special reference to the requirements of the trade in London, Leicester, and Northampton. 4. The syllabus in subjects 2, Bread Making, and 3 A, Brewing, are new, and a practical test has been added to the Honours examination in Bread Making. 5. In addition to the written examination in Typography, a practical test for Compositors will take place on the afternoon of Saturday, May 26th, 1888, at the following, and possibly at other, centres:—Aberdeen, Messrs. G. Cornwall and Sons; Ashford, Messrs. Igglesden and Son; Belfast, Messrs. Marcus Ward and Co., and Messrs. McCaw Stevenson and Oar; Birmingham, Mr. Alderman Wnite; Derby, Messrs. Bemrose and Sons; Glasgow, Messrs. Blackie and Sons; Greenwich, Messrs. Merritt and Hatcher; Guildford, Messrs. Billing and Sons; Haverfordwest, ——; Lincoln, Messrs. Akrill, Ruddock, and Keyworth; Liverpool, Messrs. Marples and Co.; London, Messrs. Cassell and Co. (Limited), Messrs. Waterlow and Sons (Limited), and Messrs. Clowes and Sons; Manchester, Co-operative Printing Society; Norwich, Messrs. Fletcher and Son; South Shields, Messrs. Simpson and Sons, and Mr. W. D. Learmount. 6. Candidates in either grade of Plumbers' Work may, in addition to the written examination in that subject, present themselves for a practical examination, to be held on the afternoon of Saturday, the 26th of May, 1888, in London, or at some other centre at which the Intitute's Examiner can attend, or at which a Local Assistant has been appointed. (Candidates who pass the practical examination in Plumbers' Work, and in other subjects in which the practical examination is optional, will receive a special certificate.) 7. The examination in all branches of subject 19, "Textile Fabrics," and in "Weaving and Pattern Designing," will be held on the afternoon of Saturday, May 26th, 1888, from 3 to 7. 8. The syllabuses of all other subjects have been carefully revised, and several important alterations have been made in some of them, particularly in subject 34, Carpentry and Joinery. 9. Additions have been made to the "Works of Reference" in several subjects. 10. Rule 22 of the Programme as to production of employer's certificate has been somewhat altered. 11. The programme contains a list of registered teachers of the Institute, and of the subjects of instruction in which they are severally registered. For the addresses of these teachers application should be made to the Office of the Institute, Exhibition Road, London, S.W.—Philip Magnus, Organising Director.

Royal Jubilee Exhibition, Manchester.—The Geissler Institute of Bonn, Germany (Dr. Geissler's Nachfolger, Franz Müller), exhibits many new instruments and ingenious examples of the glassblower's art which will excite the interest of all visitors. There are several sets of lecture apparatus for physics and chemistry; Geissler's mercury pump, fitted up with one desiccating apparatus and two receivers, for the analysis of the gases in blood; Geppert's and Pflüger's receivers. The Geissler pump is largely used by Electric Light Companies. The Jablochkoff Company, St. Petersburg, for instance, works with this kind of vacuum apparatus. Of still more general interest are several Crookes, Geissler, and Puluj tubes, especially the new form of Crookes No. 4, containing rhombs of phosphorescent minerals which give most brilliant effects, Puluj's apparatus, and a new electrical radiometer which has phosphorescent wings. A series of chemical standard thermometers, representing together the scale from −10° to +360° C., each degree divided into ½°. They are exceedingly fine and correct instruments, and handy for working with small quantities of liquids, as they are very short and thin. These standard and all other fine chemical thermometers are made of Jena normal glass. A series of medical thermometers includes a controllable instrument with the zero point graduation. Every physician should have one of these sure and easily corrected fever thermometers. There is a hypsometer baro-thermometer whose thermometer is divided into 1-100th of a degree. This extremely sensitive apparatus marks differences of height of 2 metres. The well-known vaporimeter of Dr. Geissler for the determination of alcohol in wine, beer, and vinegar, is still little employed in England. For manufacturers of soda manure, gunpowder, and dynamite, we see Lunge's nitrometer, Bunte's burette, and a series of other burettes (Hildesheimer), pipettes, graduated jars, cylinders, flasks, &c. Very interesting as fine glass blowing work are the apparatus of Norblad for sulphuretted hydrogen gas; of Brögger Harada, for the petrographical works of mineralogists; three series of Geissler stopcocks, of various forms and sizes; Pflüger litre flasks, for mixtures or dilutions of liquids, may be recommended to all chemical and physiological laboratories; Bennert's desiccator and manometer, with stopcocks and movable looking-glass scale, are both well made and practical apparatus for chemists. The thermometers, areometers, pyknometers (specific gravity bottles) with or without thermometer, of the Geissler Institute, are so

well known that we need only say the collections are of high and general interest. There are also some indications of the fact that Mr. Franz Müller keeps a large stock of metal work for chemical use, and, of course, of all apparatus and utensils which are necessary for the laboratories of chemical works and universities. As it is neither necessary nor possible in a small case to exhibit these accessories, we see only a set of chemical vessels of pure nickel, evaporating basins, crucibles, tongs, spoons, spatulas, &c.; Prof. Arzberger's gas regulator, of nickeled brass, and some more of this kind, Lists of all these exhibits contained in the show-case are placed in a conspicuous position on the stand (No. 713, main building).

Assay of Vulcanised Caoutchouc.—E. Donath (*Chem. Industrie*) shows that vulcanisation is not a phenomenon of a purely chemical order. He gives methods for the determination of the mineral substances and of the sulphur.

The Naphtha Industry: Exhibition at St. Petersburg.—The Organisation Committee of the Exhibition of Contrivances and Materials used for Lighting Purposes, and also of everything connected with the Naphtha Industry, which will take place in the winter of the present year at St. Petersburg, bring to public notice, for the information of those who desire to participate in the Exhibition, that applications will be received till the 27th of September and the exhibits till the 27th of October.

CITY AND GUILDS OF LONDON INSTITUTE,
FINSBURY TECHNICAL COLLEGE.

DAY DEPARTMENT FOR STUDENTS
Not under Fourteen Years of age.

The College Courses of Instruction in Laboratory, Lecture-room, Workshop, and Drawing Office, for Mechanical Engineers, Electrical Engineers, Technical Chemists and Builders, commence on Tuesday, October 4th.

Chemical Laboratories specially organised for instruction Technical manufacturing processes.

Fee for Session, inclusive of Laboratories, Workshops, and Drawing Office, £9.

The Entrance Examination will take place on Thursday, September 29th, at 10 o'clock a.m.

Scholarships of £30 a year each, and the Holl Scholarship of £20 a year, all tenable for two years, will be awarded (in accordance with the several schemes) on the results of the Entrance Examination.

For particulars of Scholarships and programmes of instruction apply at the Technical College, Leonard Street, City Road, E.C. or at Gresham College, E.C.

PHILIP MAGNUS, Organizing Director.
S. P. THOMPSON, Principal.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

DEMONSTRATOR AND ASSISTANT LECTURER IN CHEMISTRY. Stipend £120 a year.

ASSISTANT LECTURER IN MATHEMATICS. Stipend £100 a year.

The above appointments are now vacant. Applications, together with testimonials, must be sent in on or before Saturday, October 8th, 1887, to the undersigned, of whom all further particulars may be obtained.

IVOR JAMES,
Cardiff, September 6, 1887. Registrar.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

1. ARTS, SCIENCE, and LAW DEPARTMENT.
2. MEDICAL DEPARTMENT (including the Dental and the Pharmaceutical Courses).
3. DEPARTMENT for WOMEN.
4. EVENING CLASSES DEPARTMENT.

Prospectuses of the above Departments and of Entrance Scholarships and Exhibitions (twelve in number, and varying from £12 to £100 per annum) will be forwarded on application to the Registrar of the College, or may be obtained from Mr. J. E. CORNISH, 33, Piccadilly, Manchester.

HENRY WM. HOLDER, M.A., Registrar.

PATENT Wanted to Purchase.—An untried one not objected to, but must be likely to have large sale.—Address, D., 43, care of C. Birchall, Advertising Agent, Liverpool.

TRANSYLVANIAN, HUNGARIAN, AND OTHER EUROPEAN MINERALS.

PROF. A. E. FOOTE having just returned from a very extended trip through Europe, in which he visited Nagyag, Schemnitz, Kremnitz, and many other mining localities, offers Crystallised Gold, Crystallised Nagyagite, Sylvanite, Basite, Amethyst, Herrengrundite, Rhodochrosite in crystals and polished concentric layers, and the lovely "Himbeerspath." Cronstedtite, Pucherite, Native Tellurium, Cerussite, Tetrahedrite, Bournonite, Natrolite, Axinite, Schneebergite, Alexandrite, Green Calamine, Adamine, Anatase, Turnerite, Baverno Orthoclase, and over 100 other species, numbering several thousand specimens. These will be for sale at the

AMERICAN EXHIBITION,

where also are the Malachites banded with Azurites, that have so often been referred to in the London daily papers, Wulfenites, and other things before mentioned in the advertisements.

NEW ARRIVALS.

Bright red, beautifully terminated, Vanadinites from Arizona. We have just received a few of these that we can sell at 1s. upward, the lowest price they have ever been sold at. Also some very choice yellow Wulfenite from New Mexico. Also another lot of the beautiful Marcasite and ruby-coloured Blende; also Franklinite, Zincite, Rhodonite, &c., &c.

JENKINS' PATENT GATE VALVES
For GAS, WATER, STEAM, and CHEMICALS.
Durable, Reliable, no Ground Joints, therefore no Leaks.

Perfectly tight under any and all Pressures of WATER, STEAM, OIL, or GASES.

Sole Agents and a large stock kept by

THE VICTORIA TUBE COMPANY,
VICTORIA TUBE WORKS,
GREAT BRIDGE, STAFF.,
MANUFACTURERS OF
BEST PATENT WELDED IRON TUBES and Fittings for Gas, Steam, and Water, Galvanised Tubes and Fittings, Hydraulic Tubes.

ALL TUBES AND FITTINGS CAREFULLY TESTED BEFORE LEAVING THE WORKS.

Price Lists on application.

COLE, BROS.,
MANUFACTURERS OF CHEMICAL, ASSAY, AND BULLION BALANCES.

AUTOMATIC SORTING MACHINES FOR MINTS AND BANKERS.

BALANCES AND WEIGHTS REPAIRED AND ADJUSTED.

Balances of all kinds kept in Repair by Contract.

447, WANDSWORTH ROAD, S.W.

Price List on application.

BIRMINGHAM SCHOOL BOARD.

The Board requires the Services of an Assistant-Master for the Birmingham Bridge Street Seventh Standard Technical School. Salary £120 per annum. It is essential that the person appointed should be thoroughly qualified in Mathematics, Chemistry, and Physics.

Applications, enclosing copies of Testimonials, to be sent in on or before the 14th day of September, addressed to the Clerk of the School Board, Edmund Street, Birmingham.

THE CHEMICAL NEWS.

Vol. LVI. No. 1451.

ADDRESS TO STUDENTS.

The facilities for the study of chemistry are becoming more abundant and, in some respects at least, more efficient. There is even a possibility that at no distant date these opportunities will be still further extended, and that "chemistry for the million" will become a serious fact. But we cannot advise the young to avail themselves of the facilities offered witnout making certain reservations. We must ask the student, or rather prompt him to ask himself, what are his motives and aims in taking up the pursuit of chemistry, and not to be content without a definite answer.

If his purpose is mental cultivation; if he seeks to acquire the power of learning from things, of cross-questioning nature, or as it might be put, of observing accurately and drawing correct conclusions from his observations, we bid him go on and prosper. He will find chemistry an excellent—under many circumstances perhaps the most excellent—discipline for attaining this end.

Or, if he is born to an independent position and, possessing good abilities, purposes devoting his life to research, we would still more strongly encourage him to persevere. There is an endless quantity of work not directly remunerative, but of the highest importance, which requires to be done. Such work requires an unlimited command of time, and can, therefore, be undertaken only by persons in the position we have just mentioned. For these persons to embark in business is simply high treason against Science and against the progress of the human race.

Or, again, a young man may have before him the prospect of succeeding to the proprietorship of or a share in a brewery, a print-works, an alkali-works, or some other of the many kinds of industrial establishments which depend more or less upon chemical principles for their success. It is surely not needful to explain that in all these cases common prudence will make the acquisition of sound chemical knowledge imperative. To all such persons we should recommend not merely to aim at a special knowledge of some one part of the science which bears most directly upon their intended calling, but rather, and as a ground work, a sound general mastery of the entire science, upon which a more special and minute insight into their own department may be superinduced.

There are, again, professions in which a knowledge of chemistry is necessary. This has long been recognised with regard to medical men. The more clearly the processes, healthy or morbid, observed in the living body are understood, the more does the physician who is not a chemist feel himself at a loss.

To a less, though an increasing extent, is this the case with the legal profession. We shall not be accused of acting on the "nothing like leather" principle, if we recommend the study of chemistry to incipient solicitors and barristers. Questions concerning the validity of patents, concerning adulterations, nuisances, poisoning, &c., come before the courts often enough to render chemical knowledge useful to the lawyer.

The school-master is, in these days, often expected to teach chemistry, and he will, as a rule, not succeed in teaching what he has never learnt.

To all these different classes of persons we can give our heartiest encouragement. But there is another class, and we have every reason to fear a numerous one, to whom we can only say: Refrain! At one time it seemed likely that there might spring up a profession by means of which chemists would be able to earn a respectable livelihood by the practice of analysis, and by undertaking chemical investigations. From a variety of causes this prospect has proved a mere illusion. Chemists have been trained in such numbers that the supply exceeds the demand, and in addition there is the constant influx of foreigners, who sometimes offer their services gratuitously for half a year or more. In fact, really well-trained chemists, except they possess a practical knowledge of some one or other of the chemical arts, or enjoy special influence, are a drug in the market. The consequence is that these gentlemen have to put up with rates of payment below that of average working men. It is truly painful to us to read over the numerous letters which we receive asking for advice or recommendation. The writers can often produce excellent certificates, but there is no demand for their services. We are compelled, therefore, to advise young men to think twice before entering upon the study of chemistry as a profession.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

There are two Examinations for Matriculation in each year; one commencing on the second Monday in January, and the other on the third Monday in June. The Examination is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments,

provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

INTERMEDIATE EXAMINATION IN SCIENCE.

The Intermediate Examination in Science will be held in July, 1888.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

Examination for Honours.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination will consist of six hours' examination by two printed papers and of six hours' practical work.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself will receive an Exhibition of £40 per annum for the next two years.

B.Sc. EXAMINATION.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

Examination for Honours.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University.

The Fee for this Examination is £10.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.*

This Examination takes place twice in each year,—once, for Pass and Honours, commencing on the third Monday in July; and once for Pass Candidates only, commencing on the third Monday in January.

No Candidate shall be admitted to this Examination unless he shall have passed the Matriculation Examination, nor unless he have given notice of his intention to the Registrar at least one calendar month before the commencement of the examination.

The Fee for this examination is Five Pounds.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. Full particulars may be obtained by forwarding a stamped directed envelope to the Assistant Registrar, Cambridge, or from the *Cambridge University Calendar*.

UNIVERSITY OF DUBLIN.

TRINITY COLLEGE.

Professor of Chemistry.—J. Emerson Reynolds, M.D. F.R.S.

Assistant Lecturer.—Augustus E. Dixon, M.D., F.C.S.

Demonstrators.— William Early, F.I.C., and Emil A. Werner.

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure and Mixed Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B.Sc. Examination.

The general Laboratories now include working accommodation for 120 Students, and the Quantitative and Research Laboratories for about 40 Students. The new Lecture Hall provides full accommodation for 340 Students. Lectures will commence on November 1st.

The Laboratories and the Lectures of the Professor of Chemistry can now be attended by Students who do not desire to reside in the University or proceed to its Degrees.

The full Course of General and Analytical Chemistry occupies three years, but a Student is free in his third year to devote most of his time to a special department of Pure or Technical Chemistry. Students can enter for any portion of the Course. The following Lectures are delivered:—

1. *Inorganic Chemistry and Chemical Philosophy.* — Elementary, first year; advanced, second year.
2. *Organic Chemistry.* — General, second year; advanced, third year.
3. *Metallurgy.*—A Course for Engineering and Technical Students.

The Laboratories are open every day from 10 to 5 o'clock (except Saturdays, when they close at 1 o'clock).

The Summer Course of Practical Chemistry for Medical Students begins during the first week in April and terminates with the first week in July.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Thursday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry —One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1887-88, are Tuesday, October, 4, Tuesday, January 10, and Wednesday, April 18.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

Demonstrator.—W. G. McMillan.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The instruction given to each student is regulated by his special requirements.

Two courses of lectures will be delivered on Monday evenings by Mr. W. G. McMillan, in which especial attention will be devoted to the requirements for the examination of the City and Guilds of London Institute, viz., a Course on the "Properties of Metals and Alloys and their Uses in the Arts," and a Course on "Fuels, their Uses and Economy." A Practical Metallurgical Class will be held on Friday evenings, at which students may prepare for the examination of the Science and Art Department in Practical Metallurgy.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 3rd.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Professor.—William Ramsay, Ph.D.

Assistant Professor.—R. T. Plimpton, Ph.D.

Assistants.—S. Rideal, D.Sc., F.C.S., N. Collie, Ph.D.

The Session is divided into three Terms, as follows, all the dates being inclusive:—

First Term, from Wednesday, October 5th, until Saturday, December 17th;

Second Term, from Tuesday, January 10th, 1888, till Saturday, March 24th;

Third Term, for Lectures, from Tuesday, April 17th, till Saturday, June 16th. Class Examinations occupy about ten days, beginning on Monday, June 18th.

Students, who having entered in October do not intend to present themselves in all three subjects at the July Preliminary Science Examination, should during the first term confine their attention to Chemistry, and take this subject alone at the January Examination.

Students entering in January should take Physics and Biology at the July Examination, and Chemistry at the succeeding January Examination.

The Special Course on the Metals will be given by Mr. Rideal on Monday, Wednesday, and Friday, at 10.

Introductory or Matriculation Course.

Tuesday, Wednesday, Thursday, and Friday, at 11, commencing May 4, 1888. Fee:—£4 4s.

The Course will consist of about thirty lessons, partly theoretical and partly practical, on the non-metallic elements. Frequent exercises will be given.

General Course of Chemistry and Chemical Physics.

First and Second Terms: Inorganic.—The Class meets six times a week: Mondays, Wednesdays, and Fridays, at 11, and Saturdays, at 9, for Lectures or Examinations; and on Tuesdays and Thursdays, at 9, for Exercises.

Third Term: Elementary Organic.—Lectures or Exercises, Tuesdays, Wednesdays, and Fridays, at 11.

Fee:—For the Course, £7 7s.; Perpetual, £9 9s.; for the First or Second Terms, £4 4s.; for the Third Term, £2 2s.

The subjects treated in the First Term of the Course include those required in Chemistry at the Matriculation Examination of the University of London.

For the Preliminary Scientific Examination Students who take the three subjects for that examination in July attend during the First and Second Terms.

Extra Meetings of the Exercise Class in connection with the General Course will be held in the Third Term for those Students who intend to present themselves for the Preliminary Scientific or Intermediate Science Examination in July.

Organic Chemistry.

Tuesday and Thursday at 11, Saturday at 9, in the First Term; Monday, Wednesday, and Friday, at 9, in the Second Term; and Tuesday and Thursday, at 9, in the Third Term, beginning Wednesday, October 6th. The hour of meeting will be altered should the Class desire it.

This Course of Organic Chemistry is intended for those who in studying the subject have not a Medical Examination chiefly in view. Candidates for Honours at the Int.M.B. are, however, recommended to attend this Course during the First and Second Terms, instead of the Special Summer Course.

The Course includes the subjects required at the B.Sc. Examination, Pass and Honours; but no previous acquaintance with Organic Chemistry will be expected of those joining the Class.

Fee:—For the Course, £6 6s.; for a Term, £2 12s. 6d.

Practical Class.

First and Second Terms, on Tuesday and Thursday, at 11 or 10. Each Student will attend twice a week, at the hour allotted to him, on arrangement with the Professor.

Fee, including cost of materials, £5 5s.; for a Second Course, £3 3s.

The Course includes the Practical Chemistry required at the Preliminary Scientific, Intermediate B.Sc., and Conjoint Scheme Examinations.

Senior Practical Class.

Mondays and Saturdays from 10 to 12 during the Third Term.

Fee:—(Including cost of materials) £5 5s.; for a Second Course, £3 3s.

Matriculation Course. (Women.)

Lectures: Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Second and Third Terms, commencing Wednesday, January 11th.

Fee:—For the Course, including the cost of apparatus and materials, £4 4s.; for the Third Term, £2 12s. 6d.

Inorganic Chemistry. (Women).

Lectures and Practical Work: Wednesday at 3, Thursday at 12, Friday at 11, Saturday at 10, during the First and Second Terms, beginning on Wednesday, October 6th. The time of meeting will be altered to suit the convenience of the Class.

This Class includes the subjects required for the Preliminary Scientific and Intermediate B.Sc. Examinations. An elementary knowledge of Chemistry will be expected from students joining the class. Simple Qualitative Analysis will be practised by the Students.

Fee, including cost of apparatus and materials, £7 7s.; for one Term, £4 4s.

Analytical and Practical Chemistry.

The Laboratory is open daily from 9 a.m. to 4 p.m., Saturdays excepted, from October until the middle of July, with a short recess at Christmas and at Easter.

Fees: for the Session, £26 5s.; six months, £18 18s.; three months, £10 10s.; one month, £4 4s.

Three specified days a week:—for the Session, £15 15s.; six months, £11 11s.; three months, £6 6s.; one month, £2 12s. 6d., exclusive of expense of materials. Students may enter at any period of the Session.

The Laboratory Course includes the Practical Chemistry required at the following Examinations of the University of London:—Prel. Sci. (M.B.), Intermediate M.B., Intermediate B.Sc., B.Sc.

Students who wish to attend the Laboratory and Classes of Technical Chemistry may acquire here the requisite preliminary knowledge of Practical Chemistry and Analysis.

When accompanied by, or preceded by, attendance on the Lectures on Chemistry and Organic Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to Manufactures, Metallurgy, Medicine, or Agriculture, &c.

There is also a Chemical Library containing the chief Journals and Standard Works on Chemistry.

A Gold Medal and Certificates of Honour are competed for by Students entered for the Session.

Chemical Technology.

Professor Charles Graham, D.Sc., F.I.C.

Assistants.—C. J. Wilson, F.C.S., and W. J. Scrutton.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1887-88, it is proposed to treat of the following subjects:—

Heating and Lighting.
Metallurgy.
The Chemistry of the Alkali trade.
Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s. for the four Courses, £5 5s.

Courses of Lectures will also be delivered on the Chemistry of Brewing (fee, £3 3s.), and on Chemistry in its relation to Engineering and Architecture (fee £2 2s.).

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

Residence for Students.

Students can obtain residence at University Hall, Gordon Square. Particulars can be obtained at the office of the College.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—T. E. Thorpe, Ph.D., B.Sc., F.R.S.

Assistant Professor.—F. R. Japp, M.A., Ph.D., F.R.S.

Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.

Assistants.—G. S. Newth, H. Chapman Jones, and Dr. Gibson Dyson.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction, which lasts for three years, is the same for all the divisions during the first year, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 4th of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third year, the successful candidate being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he selects for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Students not entering for the Associateship are admitted to any particular course of study, so far as there is room, on payment of the fees shown in the following table, which must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs.	Part I. Lecs. & Lab.	Part II. Lecs. & Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.
	£	£	£	£	£
Chemistry	3	13	16	16	
Physics	5	12	12	12	
Biology with Botany	5	12			
Geology with Mineralogy	4	8	8	8	
Mechanics	4	6	8	8	
Metallurgy	2	13	15		
Mining	4	6			
Agriculture	4	10			
Astronomy	2				

Mathematics and Mechanical Drawing £3 per term. Geometrical Drawing, £3 per session. Freehand Drawing, £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science or of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who are registered by the Science and Art Department as qualified to earn payments for teaching Science may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from South Kensington, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session in Chemistry, Physics, and Mineralogy. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The College is open to male and female students not under the age of 15 years. The Session begins on Tuesday, September 20.

The Courses will be as follows.— I. Introductory and Chemistry of the Non-Metals, during Michaelmas Term. II. Chemistry of the Metals and Chemical Theory, during Lent Term. III. Organic Chemistry and Advanced Theoretical Chemistry, during Easter Term.

Course I. will suffice for the requirements of the London University Matriculation and other similar examinations. Candidates for the Intermediate B.Sc. and Preliminary Scientific (M.B.) Examinations will require Course II. as well, and must also take a course of practical instruction in the Chemical Laboratory. Course III. will meet the requirements of Students taking Chemistry in the B.Sc. and other advanced examinations.

In connection with Courses I. and II. there will be Exercise Classes meeting once a week.

The Lectures will be delivered and the Exercise Classes will meet on Tuesdays, Wednesdays, Thursdays, and Fridays at 10 a.m.

The Fee for the whole Session, paid in advance, is £10; if paid by single Terms, for the first Term of attendance in each Session £4; for the second Term, £3 10s.; for the third Term £3. Any person wishing to attend single classes may do so on payment of the sum of £1 per Term for each class.

Practical Chemistry.—The Laboratory is open to Students daily during the Session from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except Saturdays.

Special courses will be arranged for those Students who intend following Medicine, Pharmacy, Agriculture, Applied Chemistry, or other professions in which a knowledge of technical chemistry is required.

Several valuable Scholarships and Exhibitions are attached to the Studentship.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

Professor.—C. M. Thompson, M.A., D.Sc., F.C.S.
Demonstrator.—J. W. James, Ph.D., F.C.S.

The Session commences October 4th, and terminates in June, and is divided into three terms.

The Junior Course (delivered during the Michaelmas term only) consists of about 55 lectures, and will cover the subjects prescribed for the London University Matriculation examination. Fee, £2 2s.

The Intermediate Course consists of 90 lectures in continuation of the Junior Series, and, together with laboratory practice, will cover the subjects required for the Intermediate Examination in Science and the Prel. Sci. (M.B.) Examination of the University of London. Fee £3 3s.

The Senior Course includes some 90 lectures devoted to Organic Chemistry; Fee, £3 3s.

A course of 30 lectures on Qualitative and Quantitative Analysis and Chemical Calculations. £1 1s.

The Laboratory Course may be modified to meet the requirements of individual students wishing to obtain a special knowledge in some branch of manufacturing or industrial chemistry. Hours, 9 to 1 and 2 to 4.30; Saturday, 9 to 1. Fees—Six hours per week, £3 3s. per session; twelve hours, £2 2s. per term; eighteen hours, £3 3s. per term; twenty-four hours, £4 4s. per term.

Evening Lectures.—A course of Lectures will be given on Elementary Chemistry. Courses of lectures on Chemistry and the Iron and Steel Manufacture will also be delivered in certain towns in South Wales in connection with the local lecture scheme.

At the entrance examination in September, and the annual examination in June, several scholarships, &c., are awarded.

A Hall of Residence for Female Students is attached to the University, and new Chemical, Physical, &c., Laboratories will be opened by Sir William Grove in October.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—Sydney Young, B.Sc.

Lecturer.—Arthur Richardson, Ph.D.

The session 1887—88 will begin on October 4. Lectures and classes are held every day and evening throughout the Session. In the Chemical Department lectures and classes are given in all branches of theoretical chemistry, and instruction in practical chemistry is given daily in the chemical laboratory. Excursions to some of the mines, manufactories, and chemical works of the neighbourhood are occasionally made. The department of experimental physics includes various courses of lectures arranged progressively, and practical instruction is given in the physical and electrical laboratory. The Department of Engineering and the Constructive Professions is designed to afford a thorough scientific education to students intending to become engineers, or to enter any of the allied professions, and to supplement the ordinary professional training by systematic technical teaching. This department includes courses specially arranged for students intending to become civil, mechanical, electrical, or mining engineers, surveyors, or architects. Those who attend the mechanical engineering course enter engineering works during the six summer months, and, in accordance with this scheme, various manufacturing engineers in the neighbourhood have consented to receive students of the College into their offices and workshops as articled pupils. Medical education is provided by the Bristol Medical School, which is affiliated to the College. Several Scholarships are tenable at the College.

DAY LECTURES.

Inorganic Chemistry.

The Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given daily at 9 o'clock.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Fee, £3 3s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and to Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	17	15	13	10	7½
,, Two Terms ..	13	11	9	7½	5½
,, One Term ..	7	6	5	4	3
,, Month	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

Photographic Chemistry.

A Course of Lectures will be given by Mr. A. Richardson, Ph.D., on Mondays at 10, which will cover the subject as prescribed for the Technological Examination of the City and Guilds of London Institute; fee, £1 1s. for each term. The Photographic Laboratory is open from 10 to 5 every Wednesday; fee, £3 3s. for each term. A Course of Evening Lectures on the same subject will also be given on Fridays at 7.

EVENING LECTURES.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the general Principles of Chemistry and Chemical Physics and the Chemistry of Non-Metallic Elements. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 15s. for Two Terms; 10s. for One Term.

A Course of Lectures will also be delivered on Monday evenings at 8, on the Chemistry of Every-day Life.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., D.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

The Session will be opened on Monday, October 3rd, 1887.

Elementary Course.

Forty Lectures adapted to the requirements of beginners will be given in the Winter and Spring Terms. A Second Course of Twenty Lectures, having reference only to the subjects included in the syllabus of the Matriculation Examination of the University of London, will be given in the Summer Term. Lecture days—Wednesdays and Fridays at 11.30, Thursdays at 4.30.

Persons entirely unacquainted with Chemistry are recommended to attend the first of these Courses before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London are advised to attend both these Courses.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become

Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Spring and Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 9.30 a.m. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June (Summer Term). About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days—Monday, Tuesday, Wednesday, and Thursday, at 9.30 a.m. Fee, £2 2s.

In all these courses the instruction will often take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees:—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 „	8½ „
Threee Terms	18 „	12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—A Course of Twenty Lectures will be given in the Winter Term (October to Christmas), on Tuesday and Friday Afternoons at 2.30, on the Principles and Practice of Metallurgy. Fee, £1 1s. After Christmas a Course of Lectures will be given on Iron and Steel.

Arrangements have been made in the Chemical Laboratory for giving instruction in Practical Metallurgy.

Evening Classes.

A Course of Lectures on the Chemistry of Illuminants, by Professor Tilden, and on the Chemistry of Common Life, by Dr. Nicol, will be given during the Winter and Spring Terms, on Tuesdays and Fridays at 8. Fee, 5s. each.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

Chemical Department.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Systematic courses of Lectures are given on the various branches of Chemistry in its relation to Agriculture, illustrated by experiments, and by the collections in the College Museum. They comprise the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationships of their leading groups; and, finally, the applications to practical operations of the Chemistry of the atmosphere, of soils and manures, of vegetation and stock feeding, and of the processes and products of the dairy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, feeding stuffs, dairy products, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—Arthur Smithells, B.Sc. Lond., F.C.S.

Assistant Lecturers.—C. H. Bothamley, F.C.S., and Herbert Ingle.

The Session begins October 3, 1887.

Lecture Courses.

1. General Course on Systematic Chemistry—Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £5 5s.

2. Organic Chemistry—Tuesday and Thursday at 12.30 p.m., during the Second and Third Terms. Fee £2 12s. 6d.

3. Theoretical Chemistry—Advanced Course. Fee, £1 11s. 6d.

4. Lectures on Chemical Technology—Will be varied from session to session. During Session 1887-8 a Course of Lectures "On Fuel" will be given on Wednesdays, at 4 p.m., during the Second and Third Terms. Fee £2 2s.

5. Chemistry as Applied to Coal Mining—Wednesday, during the First Term, at 5.30 p.m.

6. Lectures on Laboratory Practice and Chemical Calculations—Monday, at 12.30 during the First and Second Terms. Fee, £1 1s.

7. A Class on Elementary Chemistry, consisting of about Twenty-five Lectures, on the Non-metals, will be held on Saturdays, at 12.30 p.m. Fee for the Lecture Class, 10s. 6d.

8. Photographic Manipulation—A Course of Ten Lessons will be given on Fridays, from 2 to 5, during the Third Term, with special reference to dry plate processes and silver and platinum printing. Fee, £1.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £18 18s.; five, £16 16s.; four, £14 14s.; three, £12 12s.

Class in Practical Chemistry, Saturday mornings, from 9.30 to 12.30. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 7.30 p.m., beginning October 12. Fee, 10s. 6d.

Dyeing Department.

Professor.—J. J. Hummel, F.C.S.

This Course extends over a period of three years, and is intended for those who wish to obtain a full scientific and practical education in the art of dyeing. It is suitable for those who purpose in the future to take any part in the direction of the operations of dyeing or printing of textile fabrics, *e.g.*, the sons of manufacturers, calico printers, managers, master dyers, &c.

Several valuable Scholarships are at the disposal of the College, viz., the Cavendish, Salt, Akroyd, Brown, and Clothworkers' Scholarships, and the Leighton Trustees' Exhibition.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—J. Campbell Brown, D.Sc.

Demonstrators.—C. A. Kohn, B.Sc., Ph.D., S. G. Rawson, B.Sc.

Assistant.—James B. Spurge.

The new Chemical Laboratories, which were opened in May, 1886, provide accommodation for every kind of chemical work. Besides the Chemical Lecture Theatre, seating 230, a smaller class room and a Practical Theatre accommodating 52 Students in Elementary Practical Chemistry and Qualitative Analysis, ample accommodation is provided for about 40 more advanced Students. An elaborately fitted room is provided for Organic work, which will be used temporarily as a Quantitative Laboratory, while organic operations will be carried on in a second organic room containing arrangements for combustions, operations in sealed tubes, and other special operations. Separate rooms are provided for Water Analysis, Gas Analysis, Photometry and Photography, Spectroscopic and Microscopic work. There is a balance Room, a Furnace Room, besides Stores, Service Rooms, Lavatories, and a separate room for ladies. The teaching is aided, especially in the Organic branch of the science, by a Chemical Museum. A dynamo is provided for experiments in the reduction of metals and other work employing electricity. The courses are intended to instruct the Student in Chemical Manipulation, Qualitative and Quantitative Analysis, Gas, Water, and other special branches of analysis, Organic Synthesis, Spectroscopy, Thermal Chemistry, and in the method of performing Chemical Researches, and making investigations with the view of applying Chemistry to Manufactures, Agriculture, or Hygiene, or to aid in the study of other sciences.

The Session commences October 3rd.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum:—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two days a week, during the Lent and Summer Terms; and the Practical Chemistry Class. Mathematics and Mechanics, Physics, Engineering Drawing and Design, French or German.

Second Year.—Chemistry — Second Attendance on portions of the Lecture Courses; Lectures on Organic Chemistry; Chemical Laboratory, two or three days per week, and the Practical Organic Class during the Summer Term; Technological Chemistry. Physics, Mathematics, German or French.

Third Year.—Lectures on Organic Chemistry; Lectures on Chemical Philosophy; Chemical Laboratory, four or five days per week; Technological Chemistry; Physical Laboratory, one day per week; Engineering—Strength of Materials.

The Sheridan Muspratt Chemical Scholarship of £50 per annum, tenable for two years, will be awarded in December on an Examination in subjects which are included in the first two years of the above curriculum. Other Scholarships, Entrance Scholarships, and Free Studentships are also available to Students.

The Laboratory is opened for Students from 10 a.m. to to 5 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained from Adam Holden, 48, Church St., Liverpool, price 6d.; or from the Registrar, University College, Liverpool.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5, excepting Saturdays, when they close at 1 p.m. The course of instruction is adapted to the requirements of students of Chemistry as a science, and in its applications to chemical and metallurgical industries. The fee for a three years' course of study is eighty-five guineas, or per session of three months ten guineas.

Prospectuses, containing full particulars of the day and evening classes, may be had on application at the College.

UNIVERSITY OF DURHAM.
COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator—Saville Shaw.

The Session will commence on September 26th, 1887.

Junior Division: First Year Course.—This Course of Lectures will extend over the three terms of the Session, and is intended to serve as an introduction to the Science. The Lectures will be of an elementary character, and whilst framed to meet the requirements of First Year Students will also be serviceable to such as intend pursuing Chemistry in its various applications in the arts and manufactures, as, for instance, Brewing, Metallurgy, the Manufacture of Soda, Soap, Glass, &c. The subjects treated will include an exposition of the Principles of Chemistry, and a description of the preparation and properties of the chief Elementary Substances, both metallic and non-metallic, and their more important native and artificial compounds. The class will meet on Mondays, Wednesdays, and Fridays, at 9.30 a.m., and will commence on Wednesday, October 5th.

Senior Division: Second Year Course.—A Course of about sixty Lectures will be given throughout the Session, the subject of which will be Organic Chemistry, or the Chemistry of the Carbon Compounds. This class will meet on Tuesdays and Thursdays, at 12, and will commence on Tuesday, October 4th.

Fee, for either Course, five guineas for the Session.

A Special Course will be given on Applied Chemistry, commencing Thursday, October 6th. Fee, £2 2s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be divided into two classes:—(1) Regular, or Matriculated Students; and (2) Non-Matriculated Students. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Non-Matriculated Students will attend such classes as they may select. Every candidate for admission as a matriculated student must pass

an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Examination for certificate of proficiency in General Education, held in March and September.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 17th of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, September 26th.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham in March next.

Several other valuable Scholarships are available for students.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

Professor and Director of the Chemical Laboratory.—Harold B. Dixon, M.A., F.R.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Lecturer on Technological Chemistry.—Watson Smith, F.C.S., F.I.C.

Demonstrators and Assistant Lecturers.—Watson Smith, F.C.S., Harry Baker, F.C.S., Julius B. Cohen, Ph.D., and George H. Bailey, D.Sc.

The Session begins on October 4, 1887, and ends on June 22, 1888.

The instruction is given by means of Experimental Lectures and Tutorial Classes. The Chemical Classes form part of the Courses for Chemistry in the University.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, General Course. Preparatory:—Chemical Laboratory, two days per week. Pure Mathematics. Elementary Mechanics. Geology. French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior and Senior classes. Chemical Laboratory, three days per week. Technological Chemistry Lectures. Elementary Physics or Mineralogy Lectures and Practical Courses. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, three days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry Lectures (third year's course). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

Fees.—Every student is required to pay on admission an entrance fee of £1 1s. and a library fee of 5s., and the fees for the classes for which he enters. As alternative courses are in some instances open to a student offering himself for the Victoria University Examinations, it is not practicable to give tabular statements of the fees for every combination of classes. Special prospectuses may be obtained at the office of the College.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's courses. Students so excused will nevertheless be required to undergo examination in all the subjects specified. The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

An ordinary degree of B.Sc. in Chemistry may be taken at the College in either two or three years, according as to whether the student passes the Preliminary Examination on joining the College or whether he takes a year to prepare for that examination. The Degree of B.Sc. with Honours in Chemistry can be taken in three years, and the College Certificate in Technological Chemistry may be taken in the same time.

A number of important Exhibitions, &c., are available to students.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman, F.C.S.

Lecturer on Dyeing and Metallurgy.—Mr. R. L. Whiteley, F.C.S.

The Classes of the College are open to students of both sexes above sixteen years of age. In virtue of the affiliation of the College to Cambridge University a suitable course of study is recognised in lieu of part of the ordinary residence at Cambridge for those intending to take degrees at that University. Reference should be made to the College Prospectus for fuller information.

The dates of commencement and end of Terms in the Session 1887-8 will be as follows:—First Term, October 3rd to December 17th; Second Term, January 16th to March 29; Third Term, April 16th to July 1st.

Lecture Courses.—The Chemistry Day Lectures extend over three years. In the first year a student enters for the course on Non-Metals for the first two terms and for Elementary Organic Chemistry in the third term. In his second year he takes the course on Metals for the first two terms, and Advanced Organic Chemistry in the third term. In his third year he attends a course on Applied Chemistry during the first two terms.

Fee for Day Lectures and Classes, 50s. for the session of three terms: Non-Metals or Metals 42s.: Organic Chemistry (one term) 21s.: Applied Chemistry, 30s.

Lectures on Analytical Chemistry will be given at 12 o'clock each Wednesday in term time throughout the session, and should be attended by all first year students. A similar course of lectures will be given at 6.30 on Tuesday Evenings.

A Chemical Calculation Class will meet on Friday Evenings at 7.

Fee per term, 2s. 6d.

Students may qualify themselves by attendance at these

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on this class.

lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 1 and from 2.30 to 5.30, also on Tuesday and Thursday evenings from 7 to 9. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in general Chemical Manipulation and in Qualitative and Quantitative Analysis; and students are enabled to work out the applications of Chemistry to Pharmacy, Dyeing, Agriculture, Brewing, Iron and Steel, Tanning, and other Manufacturing Processes.

Fees.—For one term, £6; for the session, £15; for day students for six hours weekly 40s., and 5s. extra for each additional hour per week; for evening students 10s. for one evening per week, and 20s. for two evenings per week.

Courses of Lectures are also given on Pharmaceutical Chemistry and Materia Medica, and on the Chemistry of Dyeing and Bleaching.

Government Lectures and Classes.—Evening Lectures and Laboratory instruction will be given by the Demonrator of Chemistry to Students who intend to present themselves for Examination by the Government Science and Art Department in May next. Inorganic, organic, and practical chemistry will be taught in the elementary and advanced stages, each of which commences at the beginning of the College Session in October. Fees for each Lecture Course, 2s. 6d.; for each Laboratory Course, 7s. 6d. Students joining these classes are expected to become candidates for the Government Examinations in May.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry.—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, F.C.S.

The Session will commence on Tuesday, October 4, 1887.

First Year's Course.—Chemistry of the Non-Metallic Elements. Monday, Wednesday, Friday, from 10 to 11 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals. Tuesday and Thursday, from 10 to 11 a.m. £2 12s. 6d.; or for the First and Second Courses, £5 5s.

Third Year's Course.—Organic Chemistry, on Wednesday, from 9 to 10, and Saturday, from 10 to 11. Fee, £2 2s.; Second and Third Courses together, £4 4s.

A Course of Lectures is arranged for Medical Students, with a special class in Qualitative Analysis.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Six hours per week, £5 5s.; Nine, £7; Twelve, £8 8s.; Eighteen, £11 5s.: Twenty-four, £14; Thirty-two, £17.

Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds and at Easter one-third of the Fees for the whole Session.

Fees for short periods (working thirty-two hours per week):—For one month, £3 3s.; two months, £5 5s.

An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for twelve hours a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Monday, 8 to 9. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, one evening per week, £1 10s.; two, £3; or Lecture Class and Laboratory, on Monday evening, £1 10s.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—Andrew Thomson, M.A., D.Sc.

The fifth session of the College will be opened on October 10th, 1887.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians and Royal College of Surgeons, London, and by the Royal College of Surgeons, Edinburgh, and for degrees in Science and Medicine by the University of St. Andrews and Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more important compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Monday, Wednesday, and Friday, from 10 to 11 a.m.; fee, £2 2s.

Second year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 3 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students:—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5 5s.; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 18, 1887.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin,

Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Mathematics, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology, including Palæontology and Mineralogy.

The D.Sc. Examination embraces Mathematics, Natural Philosophy, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

The main objects of this College are to afford a suitable education to those who wish to qualify themselves for following any industrial profession or trade, and to train teachers for technical schools. It was founded by an Order in Council, dated 26th November, 1886, according to a scheme famed by the Commissioners appointed under the provisions of the Educational Endowments (Scotland) Act, whereby Anderson's College, the Young Chair of Technical Chemistry in connection with Anderson's College, the College of Science and Arts, Allan's Glen's Institution, and the Atkinson Institution were placed under the management of one governing body.

The Diploma of the College will be awarded to Day Students who have attended the courses of instruction and passed the necessary examinations. The ordinary courses will extend over three years, but arrangements will be made for advanced students continuing their studies in special departments.

The Session opens on Monday, October 3rd, 1887.

The Courses of Lectures, &c., are given at various places as follow:—

Andersonian Buildings, Glasgow.

Professor of Chemistry.—William Dittmar, F.R.S.

Chief Assistant.—Archibald Kling.

Laboratory Assistants.—Frank Lyall, James Robson, and William Cullen.

Junior Assistants.—Andrew Reid and Andrew Hodge.

A Course of Experimental Lectures on Chemistry: Daily from 10 to 11. The Lectures up to the end of the year are devoted to an Elementary Exposition of the Philosophy and the Methods of the Science, as illustrated by the History of the Non-metallic Elements. The rest of the Session is divided between the Chemistry of the Metals and Organic Chemistry, select chapters. In addition to occasional extemporised examinations during class hours, five written examinations are held during the Session, on Saturdays from 10 to 12. Fee, £2 2s.

The Laboratory is open daily (Saturdays excepted) from 10 to 5. Advanced students may obtain permission to work privately on Saturdays also until 1 p.m. The teaching is conducted on the tutorial system, each student working by himself, at a separate place, and on his own subject. Hence students of any grade of advancement may enter at any time, and the course of instruction can be adapted to the special requirements of the individual. Original research is not forgotten, but the Professor makes it a strict rule not to use his students as his private assistants in connection with his own investigations, and rather to discourage original research with students who have not yet obtained a sufficient mastery of all the practically important methods of chemical analysis and of preparative chemistry. Fee per month, £2 2s.; due in advance. For any period of six months or more, if paid in advance, at the rate of £1 15s. per month. The fees include the use of all the ordinary reagents, and of the resources of the laboratory generally; but the student has to find his own small apparatus (test-tubes, beakers, &c.), and also a few of the more expensive reagents—*e.g.*, chloride of platinum, nitrate of silver, molybdate of ammonia.

Supplementary Courses of Lectures and Laboratory Instruction are also given by the Assistants under the superintendence of the Professor.

The "Young" Chair of Technical Chemistry, Young Laboratory Buildings.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Assistant.—Mr. C. Ellis, F.C.S.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

Lectures.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on October 3rd. These Lectures will refer mainly to the application of higher Chemistry, and are more especially intended for manufacturers, inventors, chemical engineers, and senior chemical students. Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. This Course is more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry. Fee for the Course, £ 1s.

Evening Courses.—There will be a special evening course of twenty-five lectures on Bleaching, Dyeing, and Printing, commencing on October 3rd.

There will be Practical Evening Classes in the following subjects:—Oils, Paints, and Varnishes; Bleaching, Dyeing, and Printing, &c.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, can have Private Laboratories placed at their disposal. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Science and Art Buildings.

Professor.—A. Humboldt Sexton, F.C.S.

Senior Assistant.—J. Morrow Campbell, B.Sc.

Courses of Day Lectures and Laboratory Instruction in Metallurgy and Mineralogy.

The evening classes in Chemistry, Metallurgy, and Mineralogy commence on Tuesday, October 4th.

Allan Glen's Buildings.

Lecturer.—D. S. Macnair, A.I.C., F.C.S.

UNIVERSITY OF ST. ANDREWS.

United College of St. Leonard and St. Salvator.

Evening Classes and Practical Laboratory Instruction in Inorganic and Organic Chemistry.

Professor of Chemistry. — T. Purdie, B.Sc., Ph.D., Assoc. R.S.M.

The Session begins on November 1st. A Competitive Examination, open to intending Students of Arts or Science, for twenty-five Entrance Bursaries, ranging in value from £39 to £5 each per annum, will be held on Friday and Saturday, October 28th and 29th. Two Degrees in Science are conferred by the University of St. Andrews, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.), the regulations regarding which will be found in the "University Calendar."

Lecture Course.

A Lecture is delivered by the Professor of Chemistry, at 11 o'clock, on five days in the week throughout the

Winter Session. The Course commences with the study of a few typical substances, forming an introduction to the discussion of Chemical Theory; the Non-metallic and Metallic Elements, with their chief compounds, are then considered; and the latter part of the Course is devoted to Elementary Organic Chemistry. Three Lectures weekly are of an elementary character, and are intended to be useful to Students of Arts who desire to study Chemistry as a branch of general education, or with the view of teaching it in schools; the remaining two Lectures weekly constitute a Supplementary Course, framed so as to meet the additional requirements of Candidates for the Degree of Bachelor of Science and of Medical Students.

Certificates are awarded on the results of separate examinations on the subjects of the general and supplementary Lectures.

Fee for the Session, £3 3s.

Laboratory Course.

A class in Practical Chemistry meets for two hours weekly, to which Students attending the Lectures are admitted without additional fee. The Course consists of a series of qualitative and quantitative experiments, designed to give the Student a practical acquaintance with the principles of Chemistry regarded as a subject of general education.

The Laboratory is also open during the Session from 10 a.m. to 4 p.m., for instruction in Chemical Analysis. The fee is £10 10s. for the Session. Shorter Courses of Practical Chemistry will be arranged to meet the requirements of Students who cannot give so much time to the subject, the fees for which vary according to the number of hours taken weekly.

Several free places in the Laboratory will be given to Students desirous of engaging in original work. Applicants must satisfy the Professor that their studies are sufficiently advanced to admit of them prosecuting experimental research.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

The Session begins October 18th.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—*Advanced and Organic Chemistry.*—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and at 3 p.m. after May 1st.

III.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 18th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, STEPHEN'S GREEN, DUBLIN.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 3, 1887.

The instruction comprises courses of Lectures on General, Applied, and Analytical Chemistry, and also a course of Lectures on Metallurgy.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

CITY AND GUILDS OF LONDON INSTITUTE FOR THE ADVANCEMENT OF TECHNICAL EDUCATION.—*Central Institution, Exhibition Road.*—Professor of Chemistry, H. E. Armstrong, Ph.D., F.R.S. This Institution is intended to afford such practical, scientific, and artistic instruction as shall qualify persons to become—(1) Technical teachers; (2) Mechanical, civil, and electrical engineers, architects, builders, and decorative artists; (3) Principals, superintendents, and managers of chemical and other manufacturing works. Prominent among the agencies adopted is a scheme of Technological Examinations, in connection with which a large number of classes have been instituted in the various manufacturing centres of the kingdom at which practical instruction is given in the application of Science and Art to different industries. The work done in these classes is inspected by the Institute, and, on the results of the annual examinations, certificates and prizes are granted. The Matriculation Examination will be held on Tuesday, September 27th. *Technical College, Finsbury.*—Professor of Chemistry, Raphael Meldola, F.R.S. The College fulfils the functions of a finishing technical school for those entering industrial life at a comparatively early age; of a supplemental school for those already engaged in the factory or workshop; and of a preparatory school for the Central Institution. It is under the general direction of the Principal or Superinten-

dent of Studies. At the head of each Department is a Professor, who is assisted by one or more Demonstrators; and besides these there are Lecturers and Teachers for instruction in special subjects: Skilled Artizans are employed in the Workshops for the guidance of the Students. The Session is divided into three terms:—The Winter term commences on Tuesday, October 4th. An examination for the admission of Students will be held at the College at 10 o'clock on Thursday, September 29th, 1887, and the work of the Session will commence on October 4th. The instruction consists of Day and Evening Classes and Laboratory Instruction.

Birkbeck Literary and Scientific Institution, Bream's Buildings, Chancery Lane.—*Organic Chemistry:* A course of 30 Lectures, beginning on October 4th, at 7 p.m., by Mr. H. Chapman Jones, F.C.S. A supplementary Course of about twelve lectures for more advanced students begins in January. Laboratory work and Analysis on Tuesdays, from 6 to 8 p.m. Special facilities are provided for students preparing for the Second B.Sc. (London) Practical Chemistry Examination. *Inorganic Chemistry:* A course of Thirty lectures to Elementary Students, beginning on October 4th, and a course on Chemistry and Analysis to Advanced Students, beginning on October 8th, by Mr. George Chaloner, F.C.S. Classes for Practical Chemistry and Analysis on Tuesday and Saturday evenings, beginning on October 4th.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Monday, the 3rd of October. Lectures on Chemistry and Physics, by Prof. Wyndham Dunstan, on Monday, Tuesday, and Wednesdays, at 9 a.m. Lectures on Botany by Professor Green, on Friday and Saturday mornings at 9. Demonstrations in Materia Medica by Mr. Holmes, Curator of the Society's Museums, on Thursdays at 10 a.m. Lectures and Demonstrations in Pharmacy and Practical Pharmacy by Mr. Ince, on Tuesday, Thursday, and Friday, at 5 p.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. F. W. Short, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees for the Lectures: Chemistry, One Course, (five months), £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. Botany—One Course, £2 2s.; Session, £3 3s.; Perpetual Admission, £4 4s. Pharmacy—One Course, £2 2s.; Session, £3 3s. For Practical Chemistry, 10 months, 12 to 25 guineas, according to hours of attendance. *Council Prizes.*—At the end of each of the five months Courses of Lectures, a Bronze Medal and two Certificates of Honour, and at the close of the Session (ten months) a Silver Medal and three Certificates of Honour are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and seven Certificates of Honour, offered by the Council, are competed for at the end of the Session. In the Materia Medica and Pharmacy Classes a Bronze Medal is offered for competition at the end of each Course, and a Silver Medal at the end of the Session.

New Central School of Chemistry and Pharmacy, 173, Marylebone Rd., London.—Mr. J. Woodland, F.C.S., In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine.

South London School of Pharmacy, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 9 a.m. Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

Onslow College of Science, 183, Kings Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

Royal Victoria Hall, Waterloo Bridge Road, S.E.—Science and Technical Classes, Session 1887-88. Lectures will be given in the following subjects:—Electricity and Magnetism, L. H. Owen, Esq.; Animal Physiology, Dr. Drew, B.Sc.; and Chemistry. Classes are also held in Mathematics, Plane and Solid Geometry, Machine Construction and Drawing, Applied Mechanics, and Commercial Arithmetic. The instruction given is suited to artizans and practical men, and is chiefly in connection with the Science and Art Department, South Kensington.

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Bedford College (Ladies).—Mr. S. U. Pickering, F.C.S.—Lectures commence October 15th. In the Junior Class the subjects taken are those suited for the London Matriculation Examination, while in the Senior Class the subject matter is mainly that of the Intermediate and Prel. Sci. Examinations.

Westminster College of Chemistry and Pharmacy, Trinity Square, Borough, S.E. — Messrs. Wills and Wootton.

Bristol Medical School.—Mr. T. Coomber, F.C.S.

College of Chemistry, Royal Institution, Hull. Professor, G. Carr Robinson, F.R.S.E., F.I.C., F.C.S. Lectures on Inorganic and Organic Chemistry and on the Manufacture of Oils, Colours, and Varnishes are given during the Winter months. Winter Session begins first week in October.

Institute of Chemical Technology, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus.

Leeds School of Medicine.—Prof. Smithells.

School of Science of the City and County of Lincoln.—Head-Master and Professor of Chemistry, Dr. A. B. Griffiths, F.R.S. (Edin.) F.C.S., &c. Commence September 27th, 1886. The Chemical Laboratory is fitted with every appliance, apparatus, &c., essential for furnishing a well-appointed Laboratory. The Chemical Lecture Theatre is capable of holding 300 Students. Day Lectures on Advanced Inorganic and Organic Chemistry will be given by Dr. Griffiths during the Session. These Lectures will meet the requirements of the B.Sc. (Hon.) and M.B.

Examinations of London University, &c. Mr. J. W. Horton, F.R.M.S. (Demonstrator on Chemistry) will give Junior Lecture Courses on Inorganic Chemistry, and also Lectures on Technical Chemistry. There will be Courses of Lectures on Agricultural Chemistry with Laboratory Practice, by Mr. Wallis, superintended by Dr. Griffiths.

SCHOOL OF SCIENCE AND ART, NEWCASTLE-ON-TYNE.—Chemistry and Metallurgy, Mr. P. Hawkridge, B.A.; and Mr. R. H. Jude, M.A., D.Sc.

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GLASGOW UNIVERSITY.—Prof. J. Ferguson.

GLASGOW VETERINARY COLLEGE.—Professor Cooke.

SCHOOL OF CHEMISTRY, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

CHEMICAL LABORATORY, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

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ALBERT NATIONAL AGRICULTURAL INSTITUTION, Glasnevin, Dublin (under Commissioners of National Education).—Professor of Chemistry and Geology: Sir Charles A. Cameron, M.D.

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SESSION 1887-88.

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IVOR JAMES,
Cardiff, September 6, 1887. Registrar.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1452.

THE RELATION OF SCIENCE TO THE STATE.

The relation of Science and of scientific men to the State is a question of such moment to the well-being and the progress of the whole community that we are led to venture upon its re-consideration. But at the very outset we meet with a fundamental difficulty. We find the term "Science" used, even by persons of educaticn and eminence, with a sad want of precision. In sermons and orations, in newspaper articles, and even in standard works, homœopathy, aëronautics, photography, navigation, bicycling, bill posting (!), and a mixed multitude of pursuits having no mutual connection, are spoken of as "Sciences." Science is even reproached for such evils as railway accidents, dynamitards, factory chimneys, and in short for anything of recent origin which the speaker dislikes. We have even seen it intimated in a young contemporary, that Art (probably Fine Art) is something "done" for love, whilst Science is "done" for money! No more complete misconception of the very nature of Science could be expressed in so few words.

Before, therefore, entering upon any question as to the relations of Science to the State we must, under penalty of being misinterpreted, define Science. In attempting so to do we shall be to a great extent guided by the most eminent authorities who have discussed this question. This we do with the more confidence as their conclusions are substantially unanimous, and, though often ignored, have never been formally controverted.

Thus the late Sir J. Herschel declared Science to be "knowledge digested and methodically arranged," and in another passage he defines it as the "search for laws." In a very similar manner Baron Humboldt pronounced the object of Science to be the discovery of laws. Prof. W. Whewell explains Science as the "interpretation of Nature." Sir William Grove holds it to be the "search for facts and their relations."

The late G. H. Lewes considered Science as "a knowledge of the laws of Nature," "the explanation of the phenomena of the universe," and adds that it gives us the power to "see and to foresee,"—in other words, to predict phenomena.

Everyone who carefully examines these definitions will see that they differ merely in expression, and are in their spirit identical. This becomes still more plain on reading over the works from which these passages have been selected as summarising the views of the respective anthors.

Before, however, proceeding to an exposition of the principles—or rather principle—just laid down, we must explain two terms made use of in the above definitions.

We have found mention of "phenomena." Now what is a phenomenon? It is painful that such a question need be asked. Phenomena are whatsoever we recognise by the agency of our senses, as contradistinguished from *noumena*, the supposed underlying causes of our sense-impressions. Half a century ago this was the only acceptation in which the term was used among educated men. There is in it no reference to anything unusual or surprising. The fall of a pebble released from our grasp is as much a phenomenon as the earthquake of Krakatoa. But showmen, strolling actors, and the like, *suadente diabolo*, began to apply the term to anything novel or surprising, and their example has been strangely followed. Thus in medical works we find powerful remedies, strong poisons, &c., spoken of as "phenomenal agents." In one of the reports of an influential scientific institution we saw giants and dwarfs classed as men of "phenomenal stature." Against this corruption of language we must protest, and warn all whom it may concern that in the phrase "phenomena of the universe" the word is not to be thus misunderstood.

There is then the unhappy term "laws" used in several of the definitions above quoted. Sir J. Herschel remarks that this use of the word *law* "has relation to us as understanding, rather than to the universe obeying, certain rules. To *obey* a law, to act in *compliance* with a rule, supposes understanding and will in the being who obeys and complies." But can we conceive of atoms, molecules, cells, or forms of energy as understanding and willing?

G. H. Lewes regards the term *law* as "inaccurate and misleading." A law, instead of being a mere relation of co-existence and succession, is, half unconsciously, considered to be "an abstract entity superadded to the facts, which coerces such facts and makes them to be what they are." The frequency of such expressions as "breaking the laws of Nature" proves how misleading is the term.

We are now in a position to distinguish Science from pursuits or studies with which it is often confounded. It is not mere knowledge. No accumulation of facts, however important in themselves, and however accurately observed and faithfully recorded, constitutes a Science. They must be co-ordinated, and shown forth in their relations of co-existence and succession. If this has not yet been done, or if from the arbitrary and casual nature of the facts it cannot be done, the study is erudition or learning, but not Science.

Science must also be carefully distinguished from the Arts, whether fine, useful, or useless. Here it is that the confusion we complain of is the most rampant. But the difference is easy to seize. Science sees phenomena, records them, traces their laws, and to this end questions Nature, her sole object being truth. Where completely successful she attains prevision.

Art, on the contrary, seeks to produce, to modify, or to destroy. Her sphere is action. She aims at power and enjoyment, and where completely successful she creates.

It is scarcely needful to insist that between these two pursuits there exist very intimate relations. Science is indebted to Art for her means of interrogating Nature by experiment. On the other hand, she instructs Art concerning the properties and the laws of the materials upon which the latter seeks to operate. Strictly speaking there is no such thing as "Applied Science." The moment we seek to apply we pass into the realms of Art.

But close as is the relation between Science and Art, and necessary as they are to each other, they must not be confounded, differing as they do in their objects. If we hear any pursuit spoken of as a Science, we must simply ask whether it is an attempt to interpret Nature, or to explain the phenomena of the universe? If not, however beneficial and laudable such pursuit, it is not Science.

In like manner when we hear a person designated as a "scientific man," we inquire if he is observing phenomena and tracing out their laws? If not, however vast his knowledge of the results reached by others, he is not a "man of Science."

Professor Dittmar, of the Glasgow and West of Scotland Technical College, is about to publish a series of Exercises in Quantitative Chemical Analysis, with a Treatise on Gas Analysis. The publishers are Hodge and Co., Glasgow.

Massachusetts College of Pharmacy.—We have received the Twenty-first Annual Catalogue of the College for 1887-88, in which can be found an interesting historical sketch of the origin and growth of Pharmacy in America. There is a complete list of the courses of instruction and conditions of entrance, &c., and we note especially that "women are admitted under the same conditions and with the same privileges as men."

PRELIMINARY NOTICE OF A RE-DETERMINATION OF THE ATOMIC WEIGHT OF GOLD,

WITH SOME REMARKS ON THE PRESENT STATE OF OUR KNOWLEDGE AS TO THE DETERMINATION OF ATOMIC WEIGHTS IN GENERAL.

By Prof. J. W. MALLET, F.R.S.

FOR the last two years experiments had been in progress looking to as exact a determination as possible of the atomic weight of gold, for which, until recently, there had been but very few data. Within the last few months the results had been published of two researches on this subject by others, namely, by Krüss in Germany, and by Thorpe and Laurie in England. Yet the author's work was continued, since there can scarcely be too much verification of important constants, and the methods adopted were not altogether the same as those used by the other chemists named, all whose results were obtained by essentially one and the same process. Such liability to error as belongs to this process was pointed out.

The author's own work has not yet reached the point of giving final results for publication, but the probability seemed to be that a rather higher value would be found for the atomic weight in question than that assigned by other experimenters.

It was suggested that the most important direction for advance in our knowledge of atomic weights is that of endeavouring to eliminate "constant errors," as distinguished from mere personal or casual errors of experiment. The latter we have been taught, by the example of Stas, to reduce to very small values by minute and elaborate precautions. But the former are always to be suspected, and all conceivable means should be used to avoid them. Among the most important of such means the following were pointed out:—

1st.—Resort in every case for the purification of materials used to "fractional" methods, assuming materials to be pure only when earlier and later fractions give sensibly identical results.

2nd.—Great care in the study of the reactions depended upon for final determination of atomic weights, looking especially to any possibility of the occurrence of secondary or subsidiary reactions.

3rd.—Adoption of methods by which (*a*) the atomic weight to be determined may be connected *directly* with that of hydrogen, or (*b*) if connected indirectly, by the intervention in each single determination of as *few* other elements, but in determinations by different methods, of as *many* other elements as possible of supposed well-known atomic weight.

Under this last head a method was described which had been resorted to by the author in his work on the atomic weight of gold, affording a direct connection with that of hydrogen—a method which the author believed capable of more extended application in the determination of the atomic weights of other elements. Zinc was prepared of a high degree of purity, and a given weight of the metal having been dissolved in dilute sulphuric acid, the amount of hydrogen evolved was determined by volume. A solution of auric bromide or chloride as pure as possible was treated with a known quantity of the same zinc, more than sufficient for the precipitation of the gold; the excess of zinc was dissolved by dilute sulphuric acid, and the volume of hydrogen given off was determined. The precipitated gold was carefully collected, washed, dried, and weighed. The difference between the volume of hydrogen which the zinc gave when thus partly used to replace a known quantity of gold, and the volume which it would have given if replacing hydrogen only, taken in connection with Regnault's determination of the relation of weight to volume for hydrogen, afforded of course the data needed for a direct comparison of the weights of gold and hydrogen concerned. It was pointed out that in applying this process the weight of the gold salt in solution need not be known, and that the method is not dependent upon a knowledge of the atomic weight of the halogen, combined with the gold, or of the atomic weight of zinc, and does not even require that the zinc shall be of assured purity, provided only it be uniform in character, so that a given weight of it can be depended on to yield always the same quantity of hydrogen, and there be no impurities present capable of interfering with the collection of the precipitated metallic gold in a state of purity.

* Read before the Chemical Section of the British Association, Manchester Meeting.

ON THE ANTISEPTIC PROPERTIES OF SOME OF THE FLUORINE COMPOUNDS.*

By WILLIAM THOMSON, F.R.S.Ed., F.C.S.

SOME time ago I was engaged in trying to find a substance which would act as a powerful antiseptic, &c., which was not volatile, and which was not destroyed by oxidation. I tried the effects on flour paste, and on meat chopped into small pieces and mixed with water, of a very large number of chemical compounds, and found that those which had the most remarkable antiseptic properties were the compounds of fluorine, hydrofluoric acid, the acid and neutral fluorides of sodium, potassium, and ammonium, and the fluosilicates of those bases. Of these compounds I found sodium fluosilicate to be the one which, for its powerful antiseptic and unobjectionable properties, was perhaps the best suited for the general purposes of an antiseptic. This body is not poisonous, possesses no smell, and is sparingly soluble in water. It has only a very slightly saline taste, and may be therefore employed for preserving food without communicating any taste to it.

Many experiments have been made with it for surgical purposes. A saturated solution which contains 0·61 per cent of the salt is not irritating to wounds, whilst it possesses greater antiseptic power for animal tissues than one part of perchloride of mercury in 1000 of water, which is a stronger solution than that which can be generally employed for surgical purposes without producing poisonous effects.

* Read before the Chemical Section of the British Association, Manchester Meeting.

THE REDUCTION-PRODUCTS OF THE NITRO-PARAFFINS AND ALKYL NITRITES.*

By Professor DUNSTAN and T. S. DYMOND.

THE reduction-products of ethyl nitrite have been investigated by Geuther, who used zinc and diluted sulphuric acid as the reducing agent, and found that the change represented by the equation—

$$C_2H_5NO_2+2H_2=C_2H_5OH+NH_3$$

takes place. A trace of ethylamine was also formed, but this has been attributed to impurity in the ethyl nitrite. Emil Kopp used ammonium sulphide as the reducing agent, and also obtained alcohol and ammonia, but no trace of ethylamine.

The authors have studied the reduction of ethyl nitrite, using ferrous hydroxide as the reducing agent, and have obtained an entirely different result. More than two-thirds of the nitrogen of the ethyl nitrite is liberated in the form of gas, either nitrous oxide or nitrogen; the remainder appears partly as ammonia and partly as ethylamine. If potassium hydroxide is mixed with the ferrous compound a considerable quantity of potassium hyponitrite is formed. It is also probable that ethyl hyponitrite, a compound that

has not yet been prepared, may also be formed as an intermediate compound. The authors are further investigating the change with the object of isolating this compound and of discovering the mode of formation of the ethylamine.

The reduction-products of the nitroparaffins have been studied by Victor Meyer. Nitroethane was reduced, by iron and acetic acid, to ethylamine without the formation of any ammonia:—$C_2H_5NO_2+3H_2=C_2H_5NH_2+2H_2O$. When ferrous hydroxide is used the authors find that much ethylamine is produced, a little ammonia, and a substance having a strong alliacious smell, which is being further investigated:—No gaseous product is formed. Nitromethane yields, under the same condition, methylamine, a little ammonia, and a substance having an alliacious smell. Nitro-benzene is entirely converted into aniline. The authors have previously shown (*Journal of the Chemical Society*, August, 1887) that sodium nitrite is reduced by ferrous hydroxide to nitrogen and ammonia, sodium hyponitrite being formed as an intermediate product. They intend to further investigate the reduction of the alkyl nitrites, mainly in the hope hope of being able to throw some light on the constitution of the inorganic nitrites.

ON THE MANUFACTURE OF BUTTERINE.

By THOMAS T. P. BRUCE WARREN.

WE must congratulate ourselves that recent legislation on this subject will help to unmask a manufacture which has hitherto taken refuge under a name so closely resembling butter.*

I remember, about two years ago, a question on butterine was answered in the House of Commons by a distinguished member, "that it was inexpedient to interfere with the manufacture of a wholesome article of food."

All manufacturers of what we must now call margarine are not equally scrupulous as to what they use. It is perfectly true that fat which is *doubtfully fit* for food may be so purified in the operations of converting into the so-called margarine that it passes off as wholesome (?), but, as it has been recently pointed out, an animal may be slaughtered in a diseased condition, or the fat may be infested with maggots or other organisms, and so we may get our *wholesome substitute* for butter derived from a source decidedly unpleasant to think about.

It would have been better f the Margarine Bill had contained a clause authorising inspection, so as to prevent obnoxious materials being used. Clause 9, however, directs that "every manufactory of margarine within the United Kingdom of Great Britain and Ireland shall be registered," so that we have some consolation on this point.

It is a notorious fact that good margarine costs more than some butterine is sold for. The manufacturer of margarine is not in every case the manufacturer of butterine; the margarine is agitated with milk, and cooled down until it thickens; sometimes butter itself is added, if the article is to pass off as as a veritable dairy product. Every day, almost, adds something new for the distraction of our analysts, and I fear that for some time to come the "Margarine Act 1887" will be a fruitful source of vexation.

I extract the following from the *Standard* of August 29:—"The latest vegetable fat to attract commercial attention is an extract of the *Myristica sebifera*, a so-called bean, but really a species of nutmeg, which grows wild in Guatemala, where the natives gather it and obtain the oil from it for soap and candles. The beans are in abundant supply, growing in bunches on the bushes, and they can be had at the small expense of paying Indians to gather them. A Consular Representative of Guatemala in the United States is of opinion that there is a great future in store for the fat of this vegetable, which he thinks would be a 'good substitute' for lard or butter. Machinery for crushing sesame seed, which is extensively cultivated in Guatemala, is now being sent into that country. The oil is to be exported to the United States."

I have not met with the fat of the *Myristica sebifera*, but the announcement respecting the sesame oil is significant. I may call the attention of those who are interested in this matter to an article on the Adulteration of Oils which appeared in the CHEMICAL NEWS (vol. lv., p. 134). I may just add here that if sesame oil is to replace cotton oil in the manufacture of oleo-margarine, its presence can be even more easily detected than cotton oil.

* Margarine Act, 18.7.

SEPARATION OF GOLD FROM THE PLATINUM METALS.

By W. BETTEL, Metallurgist.

IN the paper by L. Hoffmann and G. Krüss (CHEMICAL NEWS, vol. lvi., p. 83) certain assertions are made which, if allowed to pass unchallenged, would still further add to the "current statements" the authors complain of as being "in part defective and in part inaccurate."

1. *Separation by Sulphurous Acid.*

It is said by the authors that the determination of gold by precipitating its solutions with sulphurous acid is not proposed in any accessible text-book on analytical chemistry. Surely the authors would not have us believe that analytical chemists are unaware of the reducing properties of the sulphites applied to analysis! Personally I have used sulphites and sulphurous acid in analyses of gold and platinum metals—where iron was objectionable—for the past five years, and would remark that, to succeed in the separation and precipitation of gold from mixed solutions, the same conditions (*acidity*, dilution, and temperature) required for reducing an iron assay by SO_2 or sulphites applies to gold solutions. If too neutral platinum is precipitated (in traces); all the gold is not precipitated if the solution is too acid, and other causes determine the separation of a part of the gold in so finely a divided form that months are required to precipitate the last traces.

A happy medium—found by practice—secures the precipitation of 100 per cent of the gold of a purity of 999·9 per 1000. If, however, only traces of gold are to be precipitated from platinum, &c., solutions, it has been my practice to purify the resultant precipitated gold by cupellation with silver, and parting the bead obtained. It is usual, however, to throw down the platinum as double chloride, and estimate the gold in filtrate, either before or after separating palladium and traces of iridium, according to requirements.

When platinum and palladium deposits are under examination one has to attend to separation of arsenic, lead, bismuth, copper, iron, graphite, phosphorus compounds, and silica, so the mere knowledge of what takes place in neutral solutions of platinum and gold when heated with SO_2 (I am writing of *accurate* knowledge) is only an analytical curiosity to be trotted out at rare intervals.

2. *Precipitation of Gold by Oxalic Acid.*

Our authors neglect the precaution to neutralise the gold solution, and to provide for gold carried forward by evolved CO_2 and spirting. I have several times had to analyse gold (from nitric parting process) supposed to contain platinum metals, and used to take from 2000 to 5000 grains for isolation of impurities. In all cases where I have used oxalic acid as a precipitant I have returned to the office the full assayed contents of gold. (For such

large quantities of gold SO_2 is not a suitable precipitant, on account of the H_2SO_4 produced. I have used formic acid and formates with success.)

3. *Precipitation of Gold by Ferrous Chloride, and Separation from Platinum (and Palladium).*

I now come to a serious error (or "a statement in part defective and in part inaccurate") from a manufacturing point of view).

The authors seriously affirm on their unsupported testimony (in variance to Rose and Fresenius too!) that gold precipitated by ferrous chloride, from mixed solutions of gold and platinum (and palladium), contains a notable quantity of the associated metals. To quote their words:—

"According to the above analyses the gold precipitated by ferrous chloride is platiniferous."

And the "analysis" shows that 100·24 per cent of gold was obtained by such precipitation (in presence of platinum), and a maximum of 100·62 (in presence of palladium); in other words, that in solutions of gold and platinum, or palladium, a gold of purity, 997·6 per 1000, was obtained in the first case, and only 993·8 (!!) in the second.

Before I treat further of this analytical curiosity, allow me to give you an idea of my personal knowledge of the matter. I have had between five and six years' experience as a metallurgist and analytical chemist in two large refining and smelting establishments, where I had control and direct supervision over refining gold, silver, platinum, iridium metals, and palladium, by nitric, sulphuric, and aqua regia methods (precipitation by ferrous salts), &c., and separation of platinum metals from lead, bismuth, arsenic, copper and iron salts, and returning the pure metals to the office for sale. All assays, analyses, and examinations of fine metals and resulting residues, deposits, and precipitates were made by me, the accuracy of my results being periodically checked by the chief London assayer; and still I was unaware of the fact (?) that the gold I had seen, handled, assayed, and analysed was so impure. On the contrary, after the experience derived from refining over *three tons* of gold by the aqua regia process (every bar of from 100 to 300 ounces being accurately assayed to the exact decimal per 1000), I have no hesitation in saying that the statement is grossly misleading, for it being so easy to obtain (at a less cost than "nitric parting") gold of an almost chemical purity, that, at the establishment I was at the time connected with, if the refiner returned to the office a bar of gold assaying less than 999·5 per 1000 *he was not paid for that refining* (the work being done by contract, at so much per ounce of gold from sulphuric boiler), and I can personally vouch for the statement that from "platiniferous" gold assaying about—

	Per 1000.
Gold	750
Platinum metals	200
Silver and impurities	50
	1000

a gold assaying from 999·6 to 999·9 *can* be easily obtained, and, further, the principal impurity in golds assaying less than 999·9 per 1000 was silver. This is the result of over a thousand double and triple assays. I can give an additional proof of the inaccuracy of Messrs. Hoffmann and Krüss's statement.

When we wanted any "proof" gold assaying from 999·9 to as near 1000 as assays can go, I used to supervise the settling, syphoning, and precipitation of the gold, and washed the metal obtained with pure hydrochloric acid and filtered steam-water, dried and melted the precipitate with a suitable flux, and poured into a mould lined with pure carbon. The last lot of proof gold so prepared was assayed as under:—

	Per 1000 of Gold.
Johnson, Matthey, and Co.	1000·0
Claudet	999·9
Johnson and Son	999·95
W. B. (average of 3)	999·95

The assay fineness was taken for "proof" purposes at 999·9. This was prepared from an ordinary platiniferous gold which always contains palladium.

Once (at the larger of the two refineries I have been engaged in) we got platinum in our gold in a curious manner. One Monday morning—the gold having been precipitated on Saturday—the refiner called my attention to the curious appearance of the gold; beautiful cubical crystals of an orange colour, and about $\frac{1}{20}$th of an inch cube adhered to the precipitated gold. I turned to the workman and said "Why, W——, you have been putting your platinum mother-liquors (containing AmCl) in the 'ironing' jars." This he admitted he had done by an oversight. The gold assayed 995·0 per 1000, and was reworked, but the platinum came down as double chloride, not as metal.

May I suggest that impurities caused precipitation of platinum in Messrs. H. and K.'s case? At any rate I think their solitary analysis has not shaken my belief in the accurate methods of Rose and Fresenius (who have made few mistakes), to whose excellent works I am ndebted for many valuable hints in elaborating processes o meet my requirements in the works' laboratory.

The Gold, Silver, and Platinum Refinery
of Messrs. Lees and Sanders, Birmingham.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 103).

Aqueous Extracts.

Extract (1), *Bark of the Root.*

The residual powder was thoroughly dried from alcohol. It was returned to the percolator, and cold distilled water added until a definite amount had been used. The *aqueous extract* was dark coloured, and of a faintly acid reaction. A certain quantity of the *extract* was evaporated, dried, and weighed. From a known weight of the *aqueous residue*, the ash was calculated. The incineration was conduced in a covered porcelain crucible of known weight.

Total Solids.

	Per cent.
Aqueous residue dried between 100° C. and 110° C.	4·00
,, ,, ash	2·65

Gum.

One volume of the *aqueous extract* was mixed with two volumes of Squibb's stronger alcohol. The mixture was kept in a cool place for twenty-four hours, and the precipitate which had formed was collected on a weighed filter, washed with 66 per cent alcohol, dried and weighed. The precipitate and filter were incinerated in a weighed porcelain crucible, and the weight of the filter being deducted, the percentage of ash was determined.

	Per cent.
Weight of precipitate by stronger alcohol yielded	2·0
,, ,, ash yielded	0·2

Another portion of the *aqueous extract* was precipitated by stronger alcohol, and the precipitate consisted of gum and albuminous substances. It was incompletely soluble in water. The soluble matter was gum, it was recovered from solution by evaporating the liquid to dryness. The

gummy residue was almost completely soluble in cold water. It was precipitated from a concentrated aqueous solution by stronger alcohol; basic acetate of lead precipitated it as a flocculent precipitate. Borax did not thicken the gum solution, and ferric chloride and sodium chloride solutions did not precipitate it. The gum was boiled with dilute acid, and heated over a water-bath with Fehling's solution, which it reduced. A few drops of hydrochloric acid and stronger alcohol were mixed with the concentrated gum solution for the separation of arabin. It was not separated.

Carbhydrates.

The filtrate and wash alcohol from the gum precipitate were mixed, and evaporated to a syrupy consistency at a temperature of 70° to 80° C. The concentrated solution was treated with four volumes of stronger alcohol, and the resulting precipitate of *carbhydrates* rapidly filtered off. It was soluble in water. It was not precipitated from aqueous solution by basic acetate of lead, and by this means it was distinguished from vegetable mucilage.

The *carbhydrates* were boiled with dilute acid, and the solution was rendered alkaline, and heated over a water-bath with Fehling's solution. The latter was reduced.

The percentage of *carbhydrates* as estimated amounted to 0·2 per cent. An aqueous *carbhydrate* solution was mixed with a solution of barium in 40 per cent alcohol. It yielded no precipitate.

Carbhydrate Filtrate.

The *carbhydrate filtrate* was concentrated at a low temperature in a current of carbonic acid until the alcohol was dissipated. The *residue* was examined for glucose, organic acids, saponin, and tannin. Traces of glucose were detected qualitatively by Fehling's test; the amount of cuprous oxide present was too small to estimate gravimetrically. A part of the *carbhydrate filtrate residue* was boiled with 83 per cent alcohol, and filtered while hot. On cooling, a precipitate formed. This precipitate was identified as saponin. It was almost insoluble in stronger alcohol. Baryta-water precipitated it from aqueous solution. Its aqueous solutions frothed on shaking. When agitated with chloroform and on evaporating the chloroform solution, a light-coloured residue was obtained. A few drops of concentrated sulphuric acid mixed with it gave a reddish violet colour reaction. Another portion of the *carbhydrate filtrate residue* was precipitated with neutral acetate of lead and filtered. The precipitate was suspended in water, decomposed by sulphuretted hydrogen, and the lead sulphide filtrate evaporated over a water-bath to expel all odour of sulphuretted hydrogen. The liquid was cooled and lime-water added until the reaction was alkaline to litmus. A turbidity formed when the lime-water was added to the filtrate, and was not entirely cleared on the addition of dilute acetic acid. A neutralised portion of the lead sulphide filtrate gave a yellow precipitate with a ferrous salt. Oxalic acid by these tests was indicated, and possibly other vegetable acids were present in the filtrate. The *carbhydrate filtrate residue* was examined for tannin, and with a negative result. Calcium oxalate was separated.

Extract (2), the Wood of the Root.

The powder used in the alcoholic maceration was thoroughly dried, and replaced in the percolator. A measured quantity of cold distilled water was allowed to percolate slowly through the powder. The *extract* was coloured, and slightly acid in reaction. A definite volume of the *extract* was evaporated, dried, and weighed. A known weight of the *residue* was incinerated in a weighed covered porcelain crucible, and the ash determined. The ash was white and incompletely soluble in water.

Total Solids.

	Per cent.
Aqueous residue dried between 100° and 110° C. ..	12·10
,, ,, ash	1·74

Gum.

A certain quantity of the *aqueous extract* was mixed with two volumes of stronger alcohol (Squibb's). The mixture was allowed to stand for twenty-four hours, and the precipitate which formed was collected on a weighed filter. It was dried, and weighed. The precipitate and filter were incinerated in a weighed porcelain covered crucible, and the percentage of ash calculated.

	Per cent.
Weight of precipitate by stronger alcohol yielded	1·70
,, ,, ash yielded	0·34

Carbhydrates.

The filtrate and wash-alcohol from the gum precipitate were concentrated at a low temperature, and the residue was mixed with four volumes of stronger alcohol. The precipitate was rapidly filtered off, and the percentage of *carbhydrates* calculated gravimetrically in the usual way, from the amount of cupric oxide reduced from Fehling's solution. It yielded 2 75 per cent.

(To be continued).

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 87).

7. Euxenite of Hitterö and of Arendal.

DURING former researches on ytterbia, the atomic weight of ytterbium, and on scandium, several kilos. of

IX. *Holmium Material.*

Observed position of maximum darkness. Position on Telescope-drum.	Wave-length observed.	Wave-lengths formerly observed.	For.	Intensities of bands.
2353	729·0	728·3	Di	Rather strong.
2455	654·7	654·7	Er	Faint, broad.
2480	640·6	640·4	X	Strong.
2682	542·6	542·6	X	Fine and clear.
2688	539·0	—	(?)	Faint but distinct.
2698	535·5	536·3	X	Strong.
2740	523·6	523·1	Er	Faint, distinct.
2747	521·6	521·5	Di	Faint, broad.
2872	485·9	485 5	X	Strong.
2887	482·5	482·0	Di	Scarcely visible.
2920	474·9	474·5	X	Rather strong.
2943	469·4	469·0	Di	Very faint, but definite.
3030	452·0	453—449	X	Extremely strong.
3163	428·9	428·5	X	Faint.
3240	417·3	416·7	Sm	Very strong.

X. *a. Euxenite from Hitterö.*

Position of maximum darkness. Position of Telescope-drum.	Position of maximum darkness. Wave-length.	Wave-lengths formerly observed.	For.	Intensity of Bands in Spectra of Fractions. I.	II.	III.	IV.	V. and VI.	VII.
2353	729·0	728·3	Di	Strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather faint.
2413	684·4	684·0	Tm	Faint.	Faint.	Faint.	Faint.	Faint.	Faint.
2419	680·0	679·4	Di	Strong.	Rather faint.	Faint.	Very faint.	—	—
2456	654·2	654·7	Er	Extremely faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	Scarce visible.
2480	640·6	640·4	X	—	—	—	Very faint.	Faint.	Faint.
2505	621·1	621·1	Di	Faint.	Very faint.	Very faint.	—	—	—
2568	591·5	591·5	Di	Rather faint.	Rather faint	Faint.	Extremely faint.	—	—
2595	579·6	579·2	Di	Very strong.	Very strong.	Very strong.	Strong.	Strong.	Faint.
2604	575·8	575·4	Di	Very strong.	Strong.	Strong.	Faint.	Faint.	Very faint.
2682	542·6	542·6	X	Extremely faint.	Extremely faint.	Very faint.	Very faint.	Very faint.	Extremely faint
2698	535·5	536·3	X	Rather faint.	Rather faint.	Faint.	Faint.	Very faint.	Very faint.
2747	536·6	—	?	—	—	—	Very faint.	Faint.	Rather strong.
2740	523·6	523·1	Er	Extremely strong.	Strong.	Strong.	Strong.	Strong.	Rather strong.
2747	521·6	521·5	Di	Strong.	Rather strong.	Rather strong.	Faint.	Faint.	Very faint.
2780	512·5	512·2	Di	Very strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Scarce visible.
2872	485·9	485·5	X	—	—	—	—	Faint.	Faint.
2887	482·5	482·0	Di	Very strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Very faint.
2911	477·0	477·7	Sm	Strong.	Rather strong.	Rather strong.	Faint.	Very faint.	Very faint.
2920	474·9	474·5	X	—	—	—	—	Faint.	Faint.
2943	469·4	469·0	Di	Strong.	Rather faint.	Extremely faint.	Very faint.	Very faint.	Very faint.
2974	462·3	463·2	Sm	Strong.	Strong.	Strong.	Strong.	Strong.	Rather strong.
3030	452·0	453—449	X	—	—	Strong.	Very strong.	Very strong.	Very strong.
3076	444·2	444·7	Di	Very strong.	Strong.	Faint.	Very faint.	—	—
3163	428·9	428·5	X	Strong.	Rather strong.	Rather strong.	Rather faint.	Faint.	Faint.
3240	417·3	416·7	Sm	Very strong.	Very strong.	Very strong.	Very strong.	Strong.	Rather strong.

earths from the euxenites of Hitterö and Arendal had been worked up, and these were submitted to a close spectroscopic examination. The mixed nitrates were separated by the known method of partial decomposition by heat. Each nitrate solution characterised as a fraction or series in the following Tables resulted from 6 to 7 separate decompositions.

In connection herewith there was examined a material rich in holmium, obtained by heating fractions 5—43 of the euxenite earths from Hitterö. (See Table IX.)

The hitherto unidentified line $\lambda = 539{\cdot}0$ was observed in the spectrum of this holmium material; elsewhere it has been detected only in thorite and in the Brevig Wœhlerite. (See Tables X. and XI.)

(To be continued).

CHEMICAL INTEGRATION.*

By T. STERRY HUNT.

§ 1. The process of chemical union or combination has been defined as interpenetration and as identification, by Kant and by Hegel, and more recently, by the present writer, as integration; all changes in matter, as Herbert Spencer has well said, being resolvable into integration and disintegration. This process may take place either among unlike or like species, being in the latter case a homogeneous integration, constituting what is called polymerisation, while depolymerisation is a homogeneous disintegration. These two forms of the chemical process, as was defined in 1853, are respectively metamorphoses by condensation and by expansion, and were by the writer then included under the name of *chemical metamorphosis*. The relations of these homogeneous changes to heterogeneous integration and heterogeneous disintegration, which give rise to species differing in centesimal composition from the parents, and constitute what was at the same time distinguished as *chemical metagenesis*, are obvious.

§ 2. It was further shown that heterogeneous integration followed by heterogeneous disintegration or dissociation, giving rise to two species unlike the parents, constitutes what is called double decomposition, and that a similar heterogeneous integration, followed by a homogeneous dissociation, is seen when chlorine and hydrogen gases by their union give rise to chlorhydric gas, without change of volume, the condensation involved in the process of integration being immediately followed by an expansion of similar amount. The law of chemical condensation and chemical expansion being universal, there is theoretically no limit to either of these processes. Such homogeneous expansion or dissociation, it is known, takes place in elemental gaseous species, as when the vapours of sulphur and iodine are exposed to elevated temperatures, as well as in the vapours of compound species like nitric peroxide, acetic acid, and turpentine oil.

§ 3. The chemical species, to those agencies which do not effect its disintegration, is a complete entity or integer. This, in the case of homogeneous integration in gases and vapours, is generated by the condensation into a single volume of two or more volumes of a less dense species. The designation of polymers given to such condensed species, implying that they are made up of many parts, carries with it the notion of building by additions, and thus of complexity rather than of integrity: it is therefore rejected.

We assume hydrogen as the type of the normal integer, and the weight of two portions of this element ($H_2 = 2{\cdot}0$) being the unit, the weight of a like volume of any other gas or vapour is its equivalent weight; that is to say, the weight of a volume equal to H_2. This, in the language of the atomic hypothesis, is its molecular

* Read before the National Academy of Sciences at Washington, April 19, 1887.

a. Euxenite from Hitterö (continued).

Intensity of Bands in Spectra of Fractions.

VIII.	IX.	X. and XI.	XII—XVI.	XVII.—XXIV.	XXV.—XXVIII.	XXIX.—XXXIII.	XXXIV.—XLIII.
Faint.	Very faint.	—	—	—	—	—	—
Faint.	Faint.	Very faint.	Very faint.	—	—	—	—
—	—	—	—	—	—	—	—
Very faint.	Very faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint.	Extremely faint.
Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Faint.	—	—	—	—	—	—	—
Very faint.	—	—	—	—	—	—	—
xtremely faint.	Extremely faint.	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.
Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint.	Extremely faint.	Scarce visible.	Scarce visible.
Rather strong.	Rather strong.	Rather strong.	Stronger than X line λ=640·4.	Stronger than λ=640·4.	stronger than λ=640·4.	Strong.	Strong.
Rather strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Rather strong.	As VIII.	As VIII.	As VIII.	As VIII.	As VIII.	Strong.	Strong.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Rather strong.	Rather strong.	Rather strong.	Fainter than X line λ=485·5.	Rather faint.	Rather faint.	Rather strong, fainter than X line λ=485·5.	Fainter than λ=485·5
xtremely faint.	Extremely faint.	Extremely faint.	Extremely faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.
Faint.	Scarce visible.	—	—	—	—	—	—
Very strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.
—	—	—	—	—	—	—	—
Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint.	Scarce visible.	Scarce visible.	Extremely faint.
Rather strong.	Rather faint.	Faint.	Very faint.	Very faint.	Very faint.	Very faint.	Very faint.

weight, the so-called atomic weights being the smallest combining weights of the elemental species, compared with H = 1·0.

§ 4. The normal integers of oxygen, hydrogen, and chlorine, and of bromine and iodine vapours, are thus double or dyad integers, while ozone and the vapour of selenium below 800° are triple or triad, and that of sulphur vapour below 550° is sextuple or hexad; all of these, however, at higher temperatures assuming the densities of the normal or dyad integers. The quadruple integers of phosphorus and arsenic vapours, there is reason to believe, undergo a like change; while the double integer of iodine at about 1500° becomes, as is well known, a single or monad integer, a result which at the highest temperatures of experiment is already partially attained for bromine and chlorine; the vapours of mercury and cadmium being known to us only in this condition of monad integers. Such a state, from analogy, we may conceive would be attained under favourable conditions of temperature and pressure for the vapours of all known elements, and may, as the writer has elsewhere suggested, actually take place, for many species, in the electric arc; while, as he was the first to point out, in 1867, a still further dissociation, yielding unknown and still more elemental forms, probably appears in solar and nebulous matter.

The subject of homogeneous disintegration by heat is further illustrated by the vapour of nitric peroxide, of acetic acid, of paraldehyd, and of turpentine oil. These integers of varying densities, and of varying equivalent weights, alike of so-called elements and of compounds having a similar centesimal composition, may be conveniently designated higher and lower integers; the terms implying at the same time higher and lower specific gravities, and higher and lower equivalent or integral weights, since the density or specific gravity, as is well known, varies as the equivalent weight in the case of gases and vapours.

§ 5. A similar direct relation between equivalent weight and specific gravity in liquids and in solids was first indicated by the writer in 1848, and was again urged in 1853.* It was further insisted upon in a communication to the French Academy of Sciences in 1855, when after saying that "Since the chemical combination of two bodies is to be regarded as an interpenetration of masses, and not as a juxtaposition of molecules, the atomic hypothesis is not necessary for the explanation of the law of equivalent weights," it was added—"Their densities thus furnish us a means of fixing the equivalent weights of gases, and of bodies which volatilise without decomposition, and it remains to be determined if some law as simple as that of Gay-Lussac would not permit us to fix by similar means the equivalents of solids and non-volatile bodies."† The further development of this problem in subsequent years we have discussed at length in the volume cited above.

§ 6. In accordance with this conception the writer, in 1853, spoke of "that mode of metamorphosis which constitutes polymerism." The conception of polymerism or homogeneous integration as of universal application in chemistry was further insisted upon in 1867, when it was asserted that "the gas or vapour of a volatile body constitutes a species distinct from the same body in its liquid or solid state, she chemical formula of the latter being some multiple of the first; and the liquid and solid spe-

* See the author's lately published volume, "A New Basis for Chemistry," pp. 11, 12, and 38, 39, wherein the citations given below in this paragraph were, by inadvertence, omitted

† "Sur les Volumes Atomiques," *Comptes Rendus de l'Académie des Sciences*, xli., 77—81. "Puisque la combinaison chimique de deux corps doit être regardée comme une interpénétration des masses et non pas une juxtaposition des molécules, l'hypothèse atomique n'est pas nécessaire pour expliquer la loi des poids équivalents." . . . "Les densités nous fournissent ainsi un moyen de fixer les poids équivalents des gaz et des corps qui sont vaporizables sans decomposition, et il restait à déterminer si quelque loi aussi simple que celle de Gay-Lussac ne nous permettrait pas de fixer par un moyen semblable les équivalents des corps solids et non volatiles."

cies often [probably always] constitute two distinct species of different equivalent weights." It was at the same time further asserted of the liquid and solid alcohols, acids, ethers, and glycerids, that "these non-gaseous species are generated by the chemical union or identification [integration] of a number of volumes or equivalents of the gaseous species, which number varies inversely as the density of the species."* From this it follows that all condensation of gases and vapours by cold or pressure, and all fusion, solidification, and vaporisation are chemical metamorphoses. The law of volumes, hitherto applied only to gases and vapours, extends to all solid and liquid species, and is a universal law.

§ 7. The identification of the processes of vaporisation and condensation of vapours with chemical change is in accordance with the views enunciated by Henri Sainte-Claire Deville, in his researches on dissociation, between 1857 and 1865.† These views are well resumed in his final statement, in 1873, that Isambert, in his studies of the compounds of ammonia with chlorides, "not only demonstrates the analogy between the phenomena of dissociation and of vaporisation, but establishes their complete parallelism." Hence, in the opinion of Deville, "There is, according to these ideas, no essential difference between physical phenomena and chemical phenomena, or rather the passage from the one to the other is continuous."‡ It may be said, in comment upon this remarkable statement, that until the true nature of the processes of volatilisation and vaporous condensation had been established those chemical phenomena marked by changes of state had been wrongly regarded as physical (or dynamical) phenomena. By "changes of state" are here meant all changes between the conditions of gas, liquid and solid, as also the transformations of these, which are always marked by alterations in density, as well as in other physical characters. Illustrations of these changes are familiar alike in simple and in compound species.‖

§ 8. It follows from these considerations that if the law of volumes, recognised by Gay-Lussac in the changes of gases and vapours, is to be extended, as we have maintained, to their condensation into liquids and solids, so that for these, as for gases, the specific gravity is a function of the equivalent weight, we are forced to the conclusion that the equivalent or integral weights of liquids and solids are much more elevated than has been hitherto supposed. This the writer taught from 1853 up to 1885, although he had not in those years arrived at the simple means of fixing the value of these weights, subsequently set forth in 1886.§

These elevated equivalent weights furnish illustrations of the great principle of progressive series in chemistry, which, first recognised in 1842, by James Schiel, in the formula of related bodies differing by $n(CH_2)$, and in that form adopted by Charles Gerhardt in 1844, was in 1853 generalised by the present writer, and regarded as a principle of universal application. As then pointed out, progressive series in chemistry may be included under two heads,—those in which the first term is the same as the common difference, as seen in polymerisation or homogeneous integration, and those in which it is unlike the common difference. It was at that time asserted that there are progressive series,—having homologous relations between their members,—differing not only by $n(CH_2)$, but by $n(OH_2)$, by $n(OM)$, and by $n(SM)$, as well as by $n(CMO_3)$.

The subject was further pursued in a communication to the French Academy of Sciences in 1855, when it was said—"These homologous relations, far from being limited to carbon compounds, are but examples of that numeric harmony seen by Laurent, and recognised by Dumas in the equivalents of the elements, which will become for chemistry a principle as wide in its application as those of atomic weights and volumes." Of the writer's studies of the latter, it was further said by him, in 1855, that they were undertaken "in the hope of giving to mineral chemistry something of that exactitude which organic chemistry already possesses."*

(To be continued).

* *American Journal of Science*, xliii., 205; also the writer's "Chemical and Geological Essays," 456, and "A New Basis for Chemistry," 41, 42.

† "A New Basis for Chemistry," 133—137.

‡ Report by Deville on a Memoir by Troost and Hautefeuille. "Sur les Transformations Isomériques et Allotropiques"; *Comptes Rendus de l'Académie des Sciences* (1873), lxxvi. "Isambert . . . non seulement demontre l'analogie entre les phenomènes de dissociation et de vaporization, mais en établit le parallelisme complet." . . . Il n'y a aucune différence, d'après ces idées, entre les phenomènes physiques et les phenomènes chimiques, ou plutot le passage des uns aux autres se fait par des variations continues."—Deville, *loco citato*.

‖ Of phosphorus, which affords perhaps the most instructive example of these changes, there are known (1) the vaporous species, which according to Victor Meyer gives indication of conversion into a more elementary species at very high temperatures; (2) liquid phosphorus which boils at about 279°,—when it has a density of 1·5285,—and may, under proper condition, be cooled to 20° or even to 0°, but below 44° is readily changed, with rise of temperature, into the solid, transparent, colourless crystalline species (3), which is luminous in the air, soluble, poisonous, a non-conductor of electricity, having at 40° a density of 1·806. This is converted by sunlight, by the action of iodine, by a temperature of 230°, or more rapidly, with evolution of heat from the condensation, when exposed to the temperature of boiling sulphur [450°] into (4) the amorphous red species, insoluble, non-luminous, and non-poisonous, with a density of about 2·10. This species volatilises *in vacuo*, without fusion, at 550°, and is re-deposited in red crystals, which are perhaps identical with the red crystallised metalloidal species (5) got by melting lead with phosphorus under pressure, which has a density of 2·34 at 15°, and is a conductor of electricity. The forms of red phosphorus with intermediate densities are possibly mixtures of the last two species.

§ See "A New Basis for Chemistry," 100, 111.

NOTICES OF BOOKS.

Food Adulteration and its Detection: With Photomicrographical Plates and a Bibliographical Appendix. By Jesse P. Battershall, Ph.D., F.C.S., Chemist, U.S. Laboratory. New York and London: E. and F. N. Spon.

We have here a compendious manual, in which the chief sophistications of food actually practised are described, and satisfactory instructions for their detection are communicated. Substances not ranking as food are not included. The author is fully aware of the difficulty of dealing with adulteration by law and of securing a conviction when guilty knowledge has to be proved. He admits that manufacturers and dealers are often forced into adulteration by the necessities of trade competition, and that as a rule an honest dealer cannot compete with a dishonest one. But the obvious remedy is such a diligent execution of the law that the dishonest trader may find his manipulations unprofitable. Still more important would be, if it can be effected, the creation of a public opinion which will place the adulterating tradesman on the same level as the pickpocket.

After these preliminary remarks the author gives a brief history of adulteration, an art which may certainly claim a high antiquity. We learn that in the fifteenth century a wine-sophisticator of Biebrich was sentenced to drink six bottles of his own stock, and that he did not survive the experiment. English statistics here quoted are not very encouraging. In 1875-6, out of the samples analysed under the provisions of the Sale of Food and Drugs Act, the percentage of adulterated samples was 18·10, and in 1883 16·4. What our author does not mention is that in this country public interest in the working of the Act has by no means increased.

In the section on tea it is stated that according to recent reports of American consuls in China and Japan the

* *Comptes Rendus de l'Acad. des Sciences*, xii., 77-81: sur les Volumes Atomiques.—"Ces rapports d'homologie, loin d'etre limités aux composés de carbone, ne sont que des examples de cette harmonie numérique que voyait déjà Laurent, que Dumas a reconnue dans les équivalents des eléments, et qui deviendrait pour la chimie un principe d'une application aussi large que ceux des poids et des volumes atomiques." . . . . "Dans l'espoir de donner à la chimie minérale quelque chose de cette exactitude que possède déjà la chimie organique." *Loco citato*.

addition of spurious leaves to tea is now rare in those countries. The remark is made that, contrary to popular belief, there is no invariable relation between the quality of tea and its proportion of theine.

Under coffee we are told that letters patent have actually been issued for the manufacture of a fictitious "coffee-bean," containing no coffee. It is not stated what country has thus committed itself. One of the methods given for the examination of ground coffee is the colour-test, proposed by Leebody in the Chemical News, vol. xxx. The tinctorial power of chicory is three times as great as that of coffee. Of 151 samples of ground coffee recently purchased at random and tested by various American chemists, 45·7 per cent were found to be adulterated.

In discussing milk the author seems to defend the lactometer, the sin of which is not so much that it may condemn a sample unusually rich in cream as that it may absolve one skimmed and then watered. In comparing the milk of various mammals he uses the word "canine" as a substantive, though he does not name a mare an "equine" nor an ewe an "ovine."

Under butter due attention is given to the rather difficult problem of distinguishing butter from oleomargarine. Dr. Thomas Taylor some little time ago considered that when the samples are viewed by polarised light "the presence of peculiar globular crystals and the black cross commonly termed St. Andrew's cross, indicate genuine butter. In the annexed photomicrograph, however, we see, as the author points out, the St. Andrew's cross in oleomargarine. Dr. Taylor has more recently proposed another optical test. Butter, when observed by polarised light through a selenite, exhibits a uniform tint, whilst other fats observed in the same manner show prismatic colours. As regards oleomargarine, the author—very justly in our opinion—contends that it is to be condemned only when sold as butter, but not otherwise. It is certainly less digestible than genuine butter, but according to experiments here cited, only in the proportion of 1·6 per cent. The most digestible fat is cod-liver oil, then follows natural butter, then lard oil, and next the oleomargarine of commerce.

We are glad to see Mr. Battershall protesting against the common notion that water may be purified by freezing. Numerous experiments which we instituted fifteen years ago convinced us that this belief is no better than a superstition.

Amongst miscellanea we find mention of a spurious brand of red currant jelly, manufactured in France, and now finding its way into America, and doubtless into Britain also. It is prepared from a Japanese sea-weed, with the addition of glucose, tartaric acid, and an artificial "essence of currants," and coloured with cochineal and *Althea roseata*. This compound is sold at about 2½d. per lb. The flour used for maccaroni is sometimes delicately tinted with chrome-yellow.

Certain manufacturers of soda-water in New York derive their supply of water from artesian wells on their own premises, and very likely to contain sewage contamination.

Whilst regretting that we can no further carry our survey of this interesting work, we have pleasure in recommending it to chemists who practise food analysis, as well as to public health authorities.

CORRESPONDENCE.

COLOURED LIGHTS.

To the Editor of the Chemical News.

Sir,—In a "Report to the Right Honourable the Secretary of State for the Home Department, on the Circumstances attending an Explosion of Fireworks which occurred at Messrs. Dyer and Robson's Factory in Greenwich Marshes, on the 11th June, 1887, by H.M. Chief Inspector of Explosives," the following is given as the composition employed for coloured lights in the Royal Laboratory at Woolwich (page 9):—

Chlorate of potassium	2 lbs.
Nitrate of barium	5 lbs.
Sulphur	1 lb. 8 ozs.
Calomel	1 lb.
Charcoal	3 ozs.
Shellac	2 ozs.

Will you kindly allow me space to ask if any of your readers can inform me for what chemical reason the expensive calomel is employed? I have examined all the prescriptions for fireworks within my reach, but neither calomel nor any other compound of mercury is mentioned.—I am, &c.,

Practical Chemist.

September, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 6, August 8, 1887.

New Fluorescences with Well-defined Spectral Rays.—Lecoq de Boisbaudran.—Observations on the fluorescences of the aluminium "activated" by the presence of the earths $Z\alpha$ and $Z\beta$. For alumina activated with the former of these earths an energetic ignition greatly intensifies the fluorescence, transforming, at the same time, the broad nebulous bands into corresponding groups formed of distinct rays. At the same time the spectral groups are displaced towards the red. The author announces also that he has obtained very fine linear fluorescences by strongly igniting alumina containing a little didymium or praseodymium.

No. 7, August 16, 1887.

Novel Fluorescences with Well-defined Spectral Rays.—Lecoq de Boisbaudran.—The author has experimented on alumina mixed with the earth, to which he gives the name $Z\beta_2O_3$. He has also examined the fluorescences of calcined alumina containing admixtures of various oxides. With specimens rich in erbium, dysprosium, thulium, and gadolinium he has obtained spectra with rays, which will be described in a future paper. Cerium gives a fine blue fluorescence without rays. Lanthanum and yttrium did not show any fluorescence deserving notice. Ytterbium gave blue fluorescence and four small bands. Uranium does not render aluminium fluorescent.

Dissemination of the Bacillus of Tuberculosis by Flies.—MM. Spillman and Haushalter.—The authors have noticed how common flies haunt the beds of consumptive patients in hospitals, and suck up the expectorated matter. Some of these flies having been caught, and placed under glass bells, their excrements were found to contain numbers of the bacillus of Koch.

Bulletin de la Société Chimique de Paris. Vol. xlvii., No. 9, May 5, 1887.

Sweetening of Musts, Ciders, and Perries, and the Manufacture of Sugar Wines.—D. Klein and E. Fréchou.—The authors have determined the quantity of sugar to be added to grapes or to a marc to obtain a given alcoholic strength. They have also studied the means for effecting the comple inversion of the sugar added.

On Isodulcite.—Bohuslaw Rayman.—The author finds that isodulcite is a homologue of arabinose, and belongs to a new group, that of the glucoses corresponding to the quintivalent alcohols.

Action of Nitric Acid upon the Solubility of Alkaline Nitrates.—R. Engel.—Even for sodium nitrate, which has no known corresponding acid salt, the action of nitric acid is of a purely physical order only when the quantity added is inconsiderable.

Reply to M. Friedheim's Critique on the Author's Process for Titrating Sulphur in Sulphites decomposable by Hydrochloric Acid.—F. Weil.—The author's process was noticed under the *Comptes Rendus*, vol. cii., p. 1487. He maintains that the process always gives very exact and concordant results, and that its execution is easy, rapid, and convenient.

Reply to the Remarks of M. l'Abbé Godefroy on M. Roussan's Process for the Purification of Phlegms.—L. Naudin.—The writer does not find this process satisfactory.

On Anemonine.—M. Hanriot.—The author has studied the action of anemonine with reducing agents and with bromine. He obtains hydroanemonine by the action of nascent hydrogen upon bromanemonine.

Synthetic Researches on Certain Derivatives of Diphenyl.—P. Adam.—Not adapted for useful abstraction.

MISCELLANEOUS.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Student's Number:—

King's College, London.—A special course of Evening University Lectures will be given on "The Manufacture and Uses of Iron and Steel," by Mr. W. G. McMillan, F.C.S., commencing on Thursday, October 13. The first lecture will be free. Fee, £1 1s., or 10s. 6d. for Matriculated Students of any department of the College.

Leeds School of Science.—Lecturers on Chemistry and Metallurgy: J. Wertheimer, B.A., B.Sc., F.C.S., E. Rawlins, F.C.S., H. Eccles, F.C.S., and F. Matthewman. The Chemical Courses provide for students entering for the Matriculation, Intermediate, and Final B.Sc. examinations, London, and for the Pharmaceutical Society's examinations. Ladies are admitted to all the classes. Prospectuses and full information as to fees, &c., may be obtained of the Registrar, Mr. J. O. Dayson, Leeds School of Science, Cookridge Street, Leeds.

The Technical School, Manchester.—Lecturers on Chemistry, Physics, and Chemical Technology, H. Lloyd Snape, B.Sc. (Lond.), E. L. Rhead, Ernest Bentz, G. H. Hurst. The day classes commenced on August 29th, 1886, and the evening classes will commence on September 26th, 1887. First year: Lectures upon the Chemistry of the Non-metallic Elements, and of the more commonly-occurring Metals. Second year: Lectures upon the Purer Metals, Organic Chemistry, and Chemical Philosophy. In the Laboratories instruction is given in Qualitative and Quantitative Analysis. Practical classes are also held in the Metallurgical and Dyeing Laboratories. Technical Students have opportunity to attend, and are urged to join classes in mechanical drawing, and to take practical manual exercise in wood and metal working. Special practical work in any branch of Chemical Technology, or in preparation for University Examinations, will be arranged to suit individual Students. The evening Courses of instruction are especially designed to meet the wants of those already engaged in various industries. A syllabus, containing full particulars as to hours, fees, &c., may be obtained from Mr. J. H. Reynolds, The Technical School, Manchester.

Recreative Evening School Association.—President, Princess Louise; Treasurer, Cyril Flower, Esq., M.P.; Secretary, J. E. Flower, M.A. Office, 37, Norfolk St., Strand. *Object.*—To stimulate a healthy desire for knowledge on the part of boys and girls outside the range of the School Board, by presenting scientific knowledge in an attractive and popular style in evening classes, conducted by honorary teachers or lecturers in Board or other schools. Classes were conducted by this Association last winter in some 80 or 100 Board Schools, and the programme of next winter's work is on a much more extended scale. When one considers that 80,000 boys and girls leave our Board Schools annually between the ages of 14 and 18, one can readily understand there to be a want which the Association is manfully trying to supply, viz., continuance of education and the creation of a desire for scientific knowledge. The lines upon which the Association is working seem to us to be sound, inasmuch as they popularise Science rather than soar above the heads of their classes, for by means of lantern demonstrations and simple experiments they render as attractive as possible the subjects treated. The Syllabus of work for the coming season embraces, amongst others, the following subjects:—

A. *Chemistry and Physics.*—I. Chemistry (Inorganic). II. Physics.

(1) Elementary Mechanics and Pneumatics; (2) Elementary physical properties of air and water; (3) Sound; (4) Light; (5) Heat; (6) Magnetism and Electricity; (7) Physical Astronomy.

B. *Biology.*

(1) Elements of Animal Physiology; (2) Elements of Vegetable Physiology; (3) Structure of leading forms of animal life; (4) Structure of leading forms of vegetable life.

C. *Geology and Physiography.*

(1) Physical Geography; (2) Stratigraphical Geology; (3) Palæontology.

The following gentlemen form the Science Committee of this Association, and prepare popular Science lectures, illustrated with some fifty slides for each subject, which, together with suitable lanterns and all necessary apparatus, are placed in the hands of volunteer lecturers, who thus help in carrying on a noble educational work:—H. G. Rawson, Esq. (Chairman); W. Lant Carpenter, Esq.; C. Dexter Barker, Esq.; Prof. F. Jeffrey Bell; F. W. Rudler, Esq.; J. J. Harris Teal, Esq. We are particularly requested by the Science Committee to ask our readers who feel inclined to help to apply for further particulars to the Secretary, J. E. Flower, Esq., 37, Norfolk Street, Strand, W.C. PS.—All expenses are borne by the Association.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Vapour Densities.—Would any kind reader be good enough to explain without mathematical formulæ Victor Meyer's method for the determination of vapour density, and oblige a Poor Student.

TO CORRESPONDENTS.

J.H.E.N.—(1) "Laboratory Guide," by A. H. Church, Van Voorst, 2nd Edit., is the best work we know on agricultural analysis, soils, &c. (2) We know of no one work which gives the results of the analyses of various farm plants and seeds, garden seeds and bulbs. The information you require is scattered through a variety of books and journals.

Bertha Körter.—We regret we are unable to give the desired information on the healing properties of gold.

THE CHEMICAL NEWS.

Vol. LVI. No. 1453.

THE RELATION OF SCIENCE TO THE STATE.

II.

Having endeavoured to explain what Science really is, or, at any rate, to define the term as we are about to use it, we come to our real object.

It must be known to all our readers, and to thousands more of intelligent and cultivated persons, that there is considerable dissatisfaction with the present position and prospects of Science in this country. Every reader of the daily papers must have come upon utterances to this effect, delivered by men of influence and position. Now it may be asked whether, in face of what might almost be called an agitation, there is any necessity for us to take up the question? We reply that there is such necessity. It may easily happen that after much talk—as we read in the reports of Parliamentary debates—"the subject then dropped." Or it may occur that we take steps which shall lead us in the wrong direction, and which may have to be re-traced not without difficulty. It is therefore important that scientific men should at any rate compare notes and come to an understanding among themselves, and should then seek to impress the outside public—and more especially statesmen—with a true view of the case.

One satisfactory feature in the present excitement must be thankfully recognised,—*i.e.*, the growing conviction that a high standing in Science, especially in chemistry and physics, has in these days become essential to national prosperity, security, and progress. The times are past when mere energy, industry, perseverance, "pluck," were sufficient to determine success in the rivalry either between individuals or between nations. We do not in the least undervalue certain moral attributes, even though we see some countries making startling advances in their absence. We fully recognise the importance of physical superiority, health, strength, and endurance. But the question which nation shall survive as the "fittest" is after all to be determined at least as much by its intellectual supremacy. Here we must draw a further distinction: high natural intelligence is not all, it is merely a foundation; intellectual culture is not all, it may not be culture of the right kind. Historians, ethicists, musicians, orators, parliamentary or forensic,—how numerous and able soever,—may, indeed, win for themselves great *kudos* along with other more tangible advantages; but they do marvellously little to increase the resources of their country, or to raise its position in the eyes of foreigners.

It may safely be said that the arts, alike of peace and of war, are turning more and more on progress in physics and chemistry. We have, in our first paper on this subject, drawn a distinction between Science, in the strict sense of the term, and what is called "Applied Science." But without original research culminating in discovery there will be nothing to apply. Discovery is the seed (and a seed which often brings forth fruit a thousandfold) of which inventions and applications are the harvest. It stands to reason that the nation which takes the lead in discoveries will be the richest also in their "practical applications." It will at all events have the monopoly of such applications for the first few years, and this is almost everything. By the time that a newly invented industrial process has reached foreign countries the product will have fallen in price; "the cream," as men of business often put it, "has been taken off," and it is generally superseded by something newer, if not better. Surely this has been fully illustrated in the manufacture of the coal-tar colours. For the most part they have been discovered not by hap-hazard experimentation, but in consequence of speculative researches into the constitution of the coal-tar product. Their manufacture has all along flourished chiefly in the countries where such researches were made and where the discoveries were effected, that is, at first in England and France, but more recently in Germany and Switzerland.

That certain circumstances, in addition to the comparative neglect of chemical research, have contributed to the decline of the chemical arts in the United Kingdom is perfectly true. Such, *e.g.*, is the unwisdom of our patent system which allows an alien to hold a British patent, whilst refusing to work it or allow it to be worked on British ground. Such, too, is the fact that articles made abroad in infringement of a British patent can be introduced safely into this country if consigned directly to the consumer. But this is beside our immediate question.

Surely, viewing the history of the coal-tar products, we may venture to draw the conclusion that flourishing scientific research has become the necessary preliminary to superiority in industry, and that the nation which takes the lead in the one must ultimately take the lead also in the other.

We must further contend that pre-eminence in Science is an essential element of national *prestige*. We shall not enter into any hair-splitting disquisitions on the etymology of the word we have just used. Practical men understand by it that reputation which is to a community what unimpeached credit is to a merchant.

Now if we examine the causes which have led to the recent wonderful extension of German commerce—gained often at our expense—we shall see that this very intellectual *prestige* plays no small part. For instance, numbers of Japanese students of medicine resort to the German universities. When they return to their own country, and enter upon their professional career, they not unnaturally retain a preference for German pharmaceutical preparations. This leads to an increased demand in Japan for German chemicals. This commercial benefit to Germany is distinctly due to the high reputation of the German universities. A similar state of things prevails more or less elsewhere.

Again, we cannot help noticing the number of German scientific men who obtain official positions in foreign countries, such as the South American republics, Brazil, and even in the British Colonies. We find such German *savants* in charge of museums, botanical gardens, observatories. We see them appointed to professorships in universities, mining schools, and hospitals. Such men naturally acquire influence, and not having, like certain Englishmen, abjured patriotism, they use it on behalf of German interests. Do they require apparatus or materials of any kind, they recommend that these should be obtained from the Fatherland. Are they consulted, whether by public authorities or private persons, on industrial or sanitary questions, they still keep the advancement of German commerce in view.

Here, again, we see how the *prestige* of the German universities, as scientific and technical training schools, tells even in a money point of view.

The number and the success of German scientific explorers in those parts of the world not as yet fully known must not be overlooked. These men, however devoted they may be to the advancement of Science, do not overlook the advancement of German interests.

Other European countries, also, according to their opportunities, adopt a similar line of policy and foster Science, even in the most abstract departments, for the reputation and the benefits which she confers. And they have their reward.

University College, London.—Mr. Cassal has resigned the appointment of Demonstrator in the Hygienic Laboratory at University College, London.

CHEMICAL INTEGRATION.*

By T. STERRY HUNT.

Concluded from p. 138.

§ 9. In a later note, on the "Relations between certain Bodies differing by H_2 and O_2," presented to the same Academy in 1855, after recalling the above conclusions as to homologous series, it was maintained that similar relations may exist between bodies differing in their proportions of oxygen or of hydrogen. In support of this thesis, as regards oxygen, were then compared alike, chemically and crystallographically, malic and tartaric acids, chlorates and perchlorates, sulphates, carbonates and sulphatocarbonates. As regards hydrogen, the compound ammonias, $NH_3+n(CH_2)$, were compared with the analogous base piperidine, belonging to a series $NH+n(CH_2)$, and with arsine or methyl arsenid, $AsH+CH_2$. These facts and other considerations, it was then argued, "lead us to admit an intimate relation between bodies differing by H_2," as well as by $O_2(O=8)$.†

§ 10. A further illustration of this extension of the conception of progressive series was soon afterwards afforded by the studies of J. P. Cooke on the crystallised alloys of zinc and antimony, which, with similar crystalline forms, present considerable variations in the proportions of their constituents, leading him to the conclusion that "zinc and antimony are capable of uniting in other proportions than those of their chemical equivalents, or, in other words, that the law of denfiite proportions is not so absolute as has been hitherto supposed."‡ In commenting on these results, as they had been set forth by Cooke in 1860, it was said by the writer in 1874:—"These alloys of varying composition are to be regarded in part as examples of a progressive series of isomorphous compounds of antimony and zinc, of high equivalent, differing from each other nZn_2,—and in part doubtless as crystalline mixtures of these isomorphous homologous species. The principle embodied in the conception advanced by Prof. Cooke, and rightly regarded by him as of great importance to a correct science of mineralogy, he has named allomerism. It is evidently a case of homologous and isomorphous relations between members of a progressive series,—a general principle upon which I have insisted throughout the pages of this paper [one in the *Comptes Rendus* of the French Academy of Sciences for June 29, 1863, there reprinted], and which includes the polymeric isomorphism of Scheerer."§

§ 11. If now, as was argued in 1853-1855, the equivalent or integral weights of liquid and solid species are represented by very large numbers (which, as was subsequently shown, are multiples by many thousands of that of hydrogen), and if, as was then further maintained, there are found among such species bodies belonging to progressive series having as a common difference not only CH_2, OH_2, and OM, but M_2, H_2, and O, it becomes apparent that the chemical formulas of bodies so related may present ratios much less simple than those hitherto generally admitted. If, in fact, the relations perceived in surbasic salts, such as the so-called subnitrates and subsulphates, which differ among themselves by $n(MO)$ be extended to other compounds, and if oxides with elevated formulas differ among themselves by nH_2, nM, or nO, we may have not only $n(MO)$, $n(M_3O_4)$, $n(M_2O_3)$, and $n(MO_2)$, which, if $n=24$, will be—

$$M_{24}O_{24}....M_{24}O_{32}....M_{24}O_{36}....M_{24}O_{48},$$

but bodies intermediate between these, the general formula being $M_{24}O_{24}+nO$. The coefficient of M for oxides like periclase, magnetite, hematite, polianite, quartz, and cassiterite will, however, not be 24, but approximately 2400.

§ 12. The existence of oxides of such intermediate composition has lately been insisted upon by Schützenberger, who shows that oxides of tin, mercury, copper, lead, zinc, manganese, and iron, when prepared in different ways, vary considerably in their proportions of oxygen. Thus cupric oxide from the calcined nitrate evolves oxygen when dissolved in nitric acid, and ferric oxide got by a similar process, if we assume the formula to be Fe_2O_3, gives the value of Fe=54; while for a similar oxide from the calcined oxalate, if we admit the same formula, we get Fe=56. In other words, 24 parts of oxygen are in the first case united with 54, and in the second with 56, parts of iron.

Boutlerow, who confirms the results of Schützenberger, concludes from similar studies that the combining weight of carbon may vary from 12·0 to 11·8, and supposes a change in the chemical value of that element; that is to say, the amount of carbon united with 32 parts of oxygen may vary from 12·0 to 11·8 parts, the resulting compounds, though not identical, being similar in chemical properties. Schützenberger, in like manner, admits the variability in value on either side of a point of maximum stability, which is in most cases attained. He concludes that "all of these results lead directly to the conclusion that the law of definite proportions is not rigorously exact, unless we are willing to admit in each particular case the existence of compounds more or less oxygenised than those hitherto known to us, which may occur mixed with the products of the reaction."* This suggested explanation of the facts, which, however, does not appear to be acceptable to Schützenberger, Boutlerow, or Cooke (who has published a valuable discussion on the subject), is nevertheless an approximation to what we conceive to be the true one, believing, however, that the oxides with more or less than the ordinary proportions of oxygen are not necessarily nor even probably (with some apparent exceptions) admixtures, but definite intermediate oxides, being members of great progressive series.

§ 13. The conception that these variations in composition are due to the presence of admixed portions of more and less oxygenised compounds is not acceptable to Schützenberger, for the evident reason that it becomes inadmissible when we have to deal with gaseous or vaporous species, such as carbon dioxide and as water-vapour. This, as generated by passing hydrogen gas over ignited copper oxide, presents, according to him, variations in the proportions of H : O, of from 1·00 : 7·95 to 1·00 : 8·15 by weight; that corresponding rigorously to the volumetric relation 2 : 1, being, from the most probable data, very nearly 1·00 : 7·98. Water thus obtained, with an excess of oxygen, though neutral, possesses, according to Schützenberger, oxidising powers; the same being true of carbon dioxide with the larger proportion of oxygen.

§ 14. Prof. Cooke, as we have seen (§ 10) had already in 1860 arrived at a conclusion similar to that subsequently reached by Schützenberger and by Boutlerow,—namely, that "the law of definite proportions is not so absolute as has been hitherto supposed," but that the chemical value of the elements may change within certain limits. In his discussion, in 1883, of these views as enunciated by the chemists just named, Cooke remarks:—"Such opinions are certainly very revolutionary, and if they prevail must entirely change the fundamental conception

* Read before the National Academy of Sciences at Washington April 19, 1887.

† *Comptes Rendus de l'Académie des Sciences*, xli., 1167; sur les rapports entre quelques composés different par H_2 et O_2.—"Nous portent à admettre un rapport intime entre les corps différants par H_2."

‡ Cooke, *American Journal of Science*, 1883, xxvi., 310-316, resuming the conclusions of his studies of 1885 and 1860.

§ Hunt, "Chemical and Geological Essays," 447.

* See, for the papers of Schützenberger and Boutlerow, *Bull. de la Soc. Chimique de Paris* 1883, xxxix., 257-263; also an extended analysis of them in the *American Journal of Science*, 1883, xxvi., 63. The results obtained, according to Schützenberger, "conduisent directement a cette conclusion, que la loi des proportions definies n'est pas rigoreuse, a moins qu'on ne veuille admettre dans chaque cas particulier l'existence des composés plus oxigénés on moins oxigénés que ceux connus jusqu'a présent, et qui se trouveraient en mélange avec le produit principal de la réaction."

of chemical philosophy. Chemical combination can no longer be regarded as the juxtaposition of the definite invariable masses which we call atoms, but must be considered as the 'reciprocal saturation' or 'interpenetration' of masses which may vary with the relative strength of their chemical energy acting at the time; and this change of the fundamental conception is inconsistent with the atomic theory, and with the superstructure which modern chemistry has built upon it." Cooke adds that, while holding that "the atomic theory is the only basis on which a consistent philosophy can at present be built," "he is rather drawn to that view of nature which refers all differences between substances to dynamical causes, and which regards the atomic theory as only a temporary expedient for representing the facts of chemistry to the mind."*

§ 15. It has already been shown that the writer does not share the interpretation of these variations in composition given by Cooke, Schützenberger, and Boutlerow, but regards, as was already said in 1867, the facts "from which some have suggested a deviation from the law of definite proportions" as "only an expression of that law in a higher form," believing that, so far as we yet know, the laws of measure, number, and weight in chemistry are invariable. To one who since 1853 has persistently combatted the atomic hypothesis as contrary to a sound philosophy,† and throughout all the succeeding years has sought to build up without it a new theory of chemistry upon a dynamic basis, it is, however, no small satisfaction to find that Prof. Cooke, who has been among the ablest defenders of this famous hypothesis, is at last led to look upon it as "only a temporary expedient for representing the facts of chemistry to the mind."

§ 16. The question here arises whether in gaseous species like water-vapour, H_2O, and carbon dioxide, CO_2, whose integral or equivalent weights are represented by these formulas, it is possible to admit such variations in composition as have been already signalised, and as we have sought to explain in the case of liquid and solid species of high equivalent weights. We recall what has been said (§ 2, § 4) as to the process of homogeneous dissociation when the hexad integer of sulphur vapour at 500° is changed at higher temperatures into three dyad integers, and the dyad integer of iodine is at 1500° disintegrated into two monad integers, as also the integrations of pentine and aldehyd, and the homogeneous disintegration of their so-called polymers; and again, the fact that the dyad integer of hydrogen (H_2), after combining integrally with a similar integer of chlorine (Cl_2), is dissociated into two dyad integers of chlorhydric gas, 2(HCl), the double process of heterogeneous integration and homogeneous disintegration taking place without a perceptible interval, so that no change of volume is observed. The union of hydrogen and oxygen, in like manner, may be supposed to give rise temporarily to a more condensed vaporous species, which subsequently undergoes homogeneous disintegration or dissociation like sulphur and iodine vapours, or like H_2Cl_2, or dipentine,—

$$C_{10}H_{16}=2(C_5H_8).$$

Thus, while ordinary water-vapour, with the ratio for hydrogen and oxygen of 2 : 1 by volume, and of 1·0 : 7·9816 by weight, equals $(H_{100}O_{50})\div 50$, the ratio 1·0 : 8·142 corresponds to $(H_{100}O_{51})\div 50$. These figures, arbitrarily assumed, will serve for illustration; but it may be remarked that the integral weight for the gaseous species, $H_{100}O_{51}=898{\cdot}16$, which may be supposed to have a momentary existence before homogeneous disintegration, is not very much greater than the weights observed for the vapours of stannic and aluminic iodides, $SnI_4=534{\cdot}1$, and $Al_2I_6=813{\cdot}2$.

§ 17. The integral weight of liquid water with the usual volumetric ratios is represented by—

$$1628(H_2O)=29{,}244,$$

as has been shown at length in "A New Basis for Chemistry." The great importance of this datum is due to the fact that the weight of this liquid at its maximum density has, for obvious reasons, been assumed as the unit of specific gravity for all liquids and solids. For similar reasons of convenience a second arbitrary unit, the weight of atmospheric air at 0° and 760 m.m. pressure, has been adopted as the unit of specific gravity for all gases and vapours. Hydrogen gas at the same temperature and pressure, which gives us the unit of integral weight, would, however, seem to be the natural unit of specific gravity for all bodies whatsoever, and in fact the accepted integral or equivalent weights for gases and vapours are but the specific gravities of these bodies referred to hydrogen, $H_2=2{\cdot}0$; which is not only the unit of weight and volume adopted by chemists for all gases and vapours, but also the unit of weight in all calculations of the equivalent or integral weights of liquid and solid species. The values thus assigned not only to water-vapour and to gaseous carbon dioxide, but to ice, to water, to liquid and solid carbon dioxide, to quartz, and to calcite, are really the specific gravities—hydrogen gas, $H_2=2{\cdot}0$, being unity—of the normal gaseous species H_2O and CO_2, and of the possible gaseous species, silicon dioxide, SiO_2, and calcium carbonate, $CCaO_3$, which by integration, or so-called polymerisation, give rise to the liquid and solid forms of water and carbon dioxide, to tridymite and quartz, to calcite and aragonite.

If now we compare the densities of these various liquid and solid species with those of the known gaseous species H_2O and CO_2, or, in the last analysis, with the density of the hydrogen unit, H_2, we obtain a direct expression for the condensation suffered by these in passing into the liquid and solid integers. In other words, we get the specific gravity of these bodies, the dyad integer of hydrogen at 0° and 760 m.m. ($H_2=2{\cdot}0$) being unity. That of water-vapour at 100° and 760 m.m., represented by $H_2O=17{\cdot}9633$; the same volume of water at 100 being represented by $1628(H_2O)=29{,}244$. The density of all species, whether gaseous, liquid, or solid, is thus compared with that of their volumetric equivalent of hydrogen gas, ($H_2=2{\cdot}0$), at the standard temperature and pressure, and is seen to be for liquids and solids, not less than for gases and vapours, a function of their equivalent or integral weights.

§ 18. The hardness and chemical indifference of solid species are in like manner, as we have elsewhere endeavoured to show, functions of their integral weights For the study of these relations we have calculated for the species to be compared the values got by the proportion $d : p :: 1 : v$, in which d = density of weight of the liquid or solid species compared with water, $1628\,(H_2O)$ at 4°; and p = the weight of the gaseous species (or so-called molecular weight) compared with H_2 at 0° and 760 m.m. The relation $d : p$ is thus that between the densities of the solid (or liquid) and the gaseous species, and the so-called molecular volume = v is the reciprocal of the coefficient of the condensation suffered by the gaseous in passing into the solid species. The hardness and the chemical indifference of related species are inversely as the values of v.

For such species, with more or less complex formulas, it becomes necessary to fix comparable terms for p, and in the case of compound oxidised species, of which the vapour-density is unknown, we have assumed, as the unit for p, a weight including that of H = 1·0, of Cl = 35·5, or of $O\div 2=8{\cdot}0$. By thus adopting a combining weight of 8·0 for oxygen, as a basis, we get a unit which gives a common term of comparison for oxides, sulphides, chlorides, fluorides, and for intermediate compounds like the oxysulphides and oxyfluorides common in native species. It is of course a hypothetical unit, which for elemental species and for fluorides, chlorides, &c., corresponds

* *American Journal of Science* (1883), xxvi., 310. 316.
† "A New Basis for Chemistry," pp. 60-67. See also in this connection G. A. Hirn, "La Cinétique Moderne et le Dynamisme de l'avenir," *Comptes Rendus de l'Acad. des Sciences*, Sept. 20, 1886.

with the normal vaporous species; but for oxidised species is some fraction thereof, as in the cases of water, of spinels, and other oxides.

We may readily extend this system of hypothetical units to silicates, carbonates, sulphates, phosphates, and more complex species, by dividing in all cases the empirical equivalent weight by twice the number of oxygen portions (O=16·0, or more exactly 15·9633) plus the number of chlorine or fluorine portions.* We have thus for example,—

		p
Forsterite	$SiMg_2O_4=140\div8$..	17·50
Calcium carbonate	$CCaO_3=100\div6$	16·66
Calcium sulphate..	$SCaO_4=136\div8$	17·00
Gypsum..	$SCaO_4{\cdot}2(H_2O)=172\div12$ ..	14·33
Apatite	$3(P_2Ca_3O_8){\cdot}CaF_2=908\div50$..	18·16

§ 19. Such fractional units are convenient for the purpose of comparing the varying condensation in species belonging to the respective groups, but it will be borne in mind that in order to construct formulas which shall represent the true equivalent weights of liquid and solid species, we must multiply instead of dividing the formulas hitherto accepted as representing the normal species. The combining weight of these must be the unit for fixing the equivalent weights and the true formulas of such liquid and solid species, which are generated by integration or polymerisation from the normal species. This, though known to us in the volatile elements, and in compounds like carbon dioxide, water-vapour, formic and acetic aldehyds, and pentine, is unknown in the case of bodies like carbon, silicon, silicon dioxide, and most of the solid oxides; as also in the various silicates, carbonates, sulphates, and phosphates. For all these we choose, as representing the normal species, the simplest formula which satisfies the relations of valency, and which corresponds to the theoretical gaseous or volatile species.

The writer has sought in the preceding pages to illustrate and set forth in detail several points which were more briefly noticed in his lately published volume entitled "A New Basis for Chemistry," to which this paper may be considered as a supplement.

NOTES ON SOME PECULIAR VOLTAIC COMBINATIONS.†

By C. R. ALDER WRIGHT, D.Sc., F.R.S., and C. THOMPSON, F.C.S.

I. *Gas-film Electro-motors.*

The combinations referred to under this title constitute a class of cells in which the essential feature is that one or both of the "plates" of the combination consists of a film or aura of gas attracted physically to, or condensed upon, the surface of an electrically conducting solid not appreciably acted upon chemically during the production of a current, but simply serving as a support for the gas-film, which does undergo chemical change. Grove's well-known oxygen hydrogen "gas-battery," and the various analogous combinations examined subsequently by others, are cells of this kind, where *both* plates are gas-films. We have recently examined a number of combinations intermediate in character between these ordinary one-fluid or two-fluid cells, *one* plate only being a gas-film.

Single gas-film electro-motors, as these may be conveniently termed, may be ranged in two classes, according as the solid plate supporting the gas film acquires the higher or lower potential. When air, oxygen, or other electro-negative gas constitutes the film, the opposed plate being an oxidisable metal (*e.g.* copper or zinc), the former is the case; instead of an oxidisable metal, we find that an incorrodible plate (*e.g.* platinum) immersed in an oxidisable fluid (*e.g.* an acid solution of ferrous sulphate, or an alkaline one of pyrogallol) may often be employed. Gas-films of hydrogen, coal-gas and similar oxidisable gases opposed to incorrodible plates immersed in oxidising fluids (*e.g.* platinum in nitric acid or alkaline permanganate solution) furnish cells of the second class. In all cases the E.M.F. of the combination falls rapidly with increasing current density, owing to the using up of the gas-film more rapidly than the physical attracting power of the supporting plate can renew it, even under the most favourable conditions, *i.e.*, when supported horizontally on the surface of the electrolytic fluid employed so as to be simultaneously in contact therewith, and with an atmosphere of the gas experimented with.

In most cases it is desirable that the gas-film plate should not be in direct contact with the alterable fluid surrounding the plate opposed thereto; the cell thus takes the form of a two-fluid arrangement, the two liquids being on opposite sides of a porous partition, or contained in separate vessels united by an inverted syphon or asbestos wick, &c. For example, a plate or tray of spongy platinum opposed to a piece of platinum foil, the former being arranged on the surface of a solution of caustic soda in contact with the air, and the latter immersed in a solution of pyrogallol in caustic soda, conveniently protected from direct contact with air by being closed in an inverted test-tube, dipping into a somewhat more dense soda solution, connected by a syphon, &c., with the other solution.

We find that with cells of the first class, especially those where air is the gas employed, much more concordant valuations of the E.M.F. set up when generating only minute currents may be obtained, than might *à priori* be expected, provided certain precautions are taken; and that fairly accurate valuations are possible of the effect produced by varying the nature of the "aëration plate" (plate supporting the air-film), the strength and nature of the fluid surrounding it, and so on. Thus, the simplest cells of this kind (such as a plate of amalgamated zinc immersed in caustic soda solution, on the surface of which the aëration plate is arranged) appear in general to produce a higher E.M.F. the stronger the solution. The effect of varying the aëration plate, all else remaining the same, is independent of the nature of the oxidisable metal, but is influenced to some extent by the strength of the electrolytic fluid, and varies with its nature. For instance, the effect of substituting a tray of spongy platinum for an aëration plate of smooth platinum foil is to cause an increment in the E.M.F. of the cell, the numerical value of which is sensibly the same, whether zinc or lead be the oxidisable metal opposed, provided the soda solution be the same; but it is not the same, whether the soda solution be strong or weak, and is widely different, if, instead of caustic soda, dilute sulphuric acid be used as the electrolytic fluid, and similarly in other cases.

Somewhat unexpected results were obtained when certain of the more difficultly oxidisable metals (mercury, silver, and gold), were opposed to aëration plates in contact with appropriate electrolytic fluids: oxidation and solution took place with celerity. Thus mercury and silver readily form mercurous and argentic sulphates if immersed in dilute sulphuric acid, on which a platinum sponge aëration plate is arranged, on completing this circuit through a moderately large external resistance: the current produced is readily measurable by inclosing in the circuit a small silver voltameter. Silver similarly dissolves in ammonia solution (preferably containing some ammonium chloride or sulphate (when opposed to an aëration plate, as also does gold in potassium cyanide solution. Hitherto we have not succeeded in dissolving platinum in any combination of the kind.

* In the writer's essay on a Natural System in Mineralogy ("Mineral Physiology and Physiography," 279-401) the values of p and v have been thus determined. These silicates are there represented by a new notation, which employs symbols in small letters to represent quantivalent ratios; the combining weights of the elements being divided by their valency, and in all cases followed by their coefficients. The formula of forsterite thus becomes $(mg_1\ i^1)o_2$, that of orthoclase $(k_1al_2si_{12})o_{16}$, and that of topaz $(al_2si_2)o_4fl$.

† Read before the Chemical Section of the British Association, Manchester Meeting.

II. *Voltaic Circles producible by the Mutual Neutralisation of Acid and Alkaline Fluids, supplemented by other Agencies.*

It has long been known that if an acid and an alkaline solution be united (by means of a wick or syphon, &c.), a considerable current is producible for a short time in the external circuit, connecting two plates of platinum, &c., immersed in the two fluids respectively; but this current very rapidly diminishes to infinitesimal proportions. The usual explanation of this, given in the text-books, is that during the passage of the current electrolysis takes place, causing the development of free hydrogen on the surface of the plate in the acid fluid, and of oxygen on that of the other plate, so that an inverse E.M.F. is set up by the incipient gas battery thus produced, which by-and-bye becomes practically equal to the E.M.F. due to the chemical action of neutralisation. No direct quantitative proof of this electrolysis, however, appears ever to have been given as regards the hydrogen; whilst as regards the oxygen, the main evidence is the observation of Becquerel, that if nitric acid be the acid and caustic potash the alkali, a tolerably constant current is developed, the flow of which is accompanied by continuous evolution of oxygen from the alkali plate, whence the term "pile à oxygène" applied by him to the combination, the nitric acid being simultaneously reduced to lower oxides of nitrogen.

Whilst studying the action of various gas film cells, we had occasion to make some experiments with "neutralisation cells," *i.e.*, cells in which one essential feature is that an acid and an alkaline fluid are used, which neutralise one another during the action; thus in the case of Becquerel's "pile à oxygène," the scheme—

$$2HNO_3 \mid 2KNO_3 \mid 2KOH$$
$$H_2 \mid 2NO_3K \mid 2NO_3K \mid OH_2 \mid O$$

represents the primary action, the hydrogen, of course, not appearing as such, but reducing the nitric acid. We found it difficult to obtain by titration very sharp figures, proving that one equivalent of acid disappears on one side and one of alkali on the other, for every equivalent of silver thrown down by the current in a silver voltameter; but our results always at least approximated to this. On the other hand we found no difficulty at all in proving that in Becquerel's "pile à oxygène," 8 m.grms. of oxygen (5·6 c.c. at 0° and 760 m.m.) are evolved for every 108 m.grms. of silver deposited. Moreover, we found that various oxidising fluids can be substituted for nitric acid without affecting this result; thus, solution of potassium permanganate or ferricyanides acidulated with sulphuric acid; chromic acid dissolved in sulphuric acid; hydrochloric acid saturated with chlorine; or dilute sulphuric acid saturated with bromine, all cause oxygen evolutions (though not all as rapidly as nitric acid) in precisely the quantity equivalent to the silver deposited.

It occurred to us that by suitably modifying the liquids used we might obtain similar quantitative evidence as regards the hydrogen. If nitric acid or other oxidising agent can be reduced by the nascent hydrogen whilst the oxygen escapes, it might be expected that if some highly oxidisable substance is dissolved in the caustic alkali used, the oxygen might be arrested whilst still nascent, whilst conversely the hydrogen escaped free at the other side; and this, in fact, we ultimately succeeded in doing. Several oxidisable substances, however, proved too weak; thus, sulphites and ferrocyanides caused no distinct hydrogen evolutions; but caustic soda containing hyposulphite (Schützenberger's "hydrosulphite") or pyrogallol caused continuous evolution of hydrogen in quantity strictly proportionate to the current passing, *i.e.*, 11·2 c.c. normal for every 108 m.grms. of silver deposited.

Precisely the same result was obtained when certain metals not ordinarily soluble in cold acid or alkaline fluids, and simple caustic soda solution were used instead of these alkaline oxidisable fluids with platinum plates. Thus, tin and lead immersed in caustic soda and opposed to platinum in dilute sulphuric acid dissolved freely, producing copious evolutions of hydrogen from the platinum plate surface. The same result was obtained on substituting copper and ammonia solution for tin and caustic soda; whilst by employing strongly alkaline potassium cyanide solutions, mercury, silver, gold, and palladium were readily dissolved with hydrogen evolutions from the opposed platinum plate immersed in dilute sulphuric acid. In all these different cases the amount of hydrogen obtained was exactly proportionate to the current flowing, 11·2 c.c. being collected for every m.grm. equivalent of silver deposited in the voltameter.

A NEW METHOD FOR DETERMINING MICRO-ORGANISMS IN AIR.*

By Professor CARNELLEY and THOS. WILSON,
University College, Dundee.

THIS is a modification of Hesse's well-known process. It consists essentially in the substitution of a flat-bottomed conical flask for a Hesse's tube. Its chief advantages are:—(1) Much smaller cost of flask and fittings as compared with Hesse's tubes; (2) very much fewer breakages during sterilisation; (3) great economy in jelly; (4) freedom from leakage during sterilisation; (5) results not vitiated by aërial currents.

THE SOLUBILITY OF ISOMERIC ORGANIC COMPOUNDS.*

By Professor CARNELLEY, D.Sc., and Dr. A. THOMSON,
University College, Dundee.

1. *For any series of isomeric organic compounds the order of solubility is the same as the order of fusibility, i.e.* the most fusible compound is also the most soluble. (*Cf.* Carnelley, *Phil. Mag.* (5); also Tilden, *Phil. Trans.*).

This is shown to hold true in a very large number of cases, whilst there are very few exceptions, and those of a doubtful character.

2. *The order of solubility of two or more isomeric compounds is independent of the nature of the solvent.* This has been experimentally proved, more particularly in the case of meta- and para-nitraniline, the solubility of each of which in thirteen different solvents has been determined. Also by a considerable number of cases taken from literature.

3. *The ratio of the solubilities of two isomers in a given solvent is constant, and is therefore independent of the nature of the solvent.* So that—

$$\frac{\text{Solubility of A in any solvent}}{\text{Solubility of B in the same solvent}} = \text{constant.}$$

This has been proved for meta- and para-nitraniline in respect of thirteen different and very varied solvents.

ON THE COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 137).

LASTLY, the accompanying measurements (see Table XII.) of some mother-liquors are of importance for the study of the components of erbium and of thulium. They

* Read before the Chemical Section of the British Association Manchester Meeting.

XI. *b. Euxenite from Arendal.*

Position of maximum darkness.				Intensity of the Absorption-bands of the Several Fractions.					
Position of Telescope-drum.	Wave-length.	Wave-lengths formerly observed.	For.	I.	II.	III.	IV.	V.	VI.
2353	729·0	728·3	Di	Strong.	Rather strong.	Rather strong,	Rather strong.	Rather strong.	Medium stron
2394	716·4	—	?	—	—	—	—	—	—
2415	683·2	684·0	Tm	Extremely faint.	Very faint.	Faint.	Faint.	Faint.	Rather faint.
2419	680·0	679·4	Di	Very faint.	Extremely faint.	—	—	—	—
2455	654·7	654·7	Er	Rather strong.	Strong.	Strong.	Strong.	Strong.	Strong.
2480	640 6	640·4	X	—	—	—	—	—	—
2505	621·1	621·1	Di	Faint.	Extremely faint.	—	—	—	—
2568	591·5	591·5	Di	Rather faint.	Very faint.	Extremely faint.	—	—	—
2595	579·6	579·2	Di	Very strong.	Strong.	Rather strong.	Faint.	Faint.	Faint.
2604	575·8	575·4	Di	Strong.	Rather strong.	Faint.	Very faint.	Very faint.	Extremely fair
2682	542·6	542·6	X	Rather strong.	Rather strong.	Strong.	Strong.	Strong.	Strong.
2698	535·5	536·3	X	Rather strong.	Rather strong.	Strong.	Strong.	Strong.	Strong.
2740	523·6	523·1	Er	Strong.	Strong.	Strong.	Very strong.	Very strong.	Extremely strong.
2747	521·6	521·5	Di	Rather strong.	Rather strong.	Rather strong.	Rather faint.	Very faint.	—
2780	512·5	512·2	Di	Rather faint.	Faint.	—	—	—	—
2872	485·9	485·5	X	—	—	Rather faint.	Rather strong.	Rather strong.	Rather strong
2887	482·5	482·0	Di	Rather strong.	Strong.	Rather faint.	—	—	—
2910	474·9	474·5	X	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather faint.
2943	469·4	469·0	Di	—	—	Very faint.	Very faint.	Very faint.	Faint.
2974	462·3	463·2	Sm	Rather faint.	Very faint.	—	—	—	—
3028	452·6	453—449	X	Very strong.	Strongest line of this fraction.	Very strong.	Extremely strong.	Extremely strong.	Extremely strong.
3076	444·2	444·7	Di	Rather strong.	Rather faint.	Faint.	Faint.	Faint.	Faint.
3163	428·9	428·5	X	Rather strong.	Rather strong.	Rather strong,	Rather faint.	Faint.	Faint.
3240	417·3	416·7	Sm	Strong.	Strong.	Strong.	Strong.	Strong.	Strong.

XII. *c. Mother Liquors obtained in Preparing Pure Ytterbia.*

Position of maximum darkness.				Intensity of Absorption-bands in Spectra of the Several Series.					
Position of Telescope-drum.	Wave-length.	Wave-length formerly observed.	For.	41—46.	47—53.	54—60.	61—62.	63—65.	66—67.
2394	716·4	—	?	Very faint.	Extremely faint.	—	—	—	—
2413	684·4	684·0	Tm	Strong.	Strong.	Rather faint.	Very faint.	Extremely faint.	Scarce visible
2455	654·7	654·7	Er	Extremely faint.	Extremely faint.	Scarce visible.	—	—	—
2682	542·6	542·6	X	Scarce visible.	—	—	—	—	—
2740	523·6	523·1	Er	Very faint.	Scarce visible.	—	—	—	—
2872	485·9	485·5	X	Extremely faint.	—	—	—	—	—
2920	474 9	474·5	X	Scarce visible.	—	—	—	—	—
2693	464·9	465·0	Tm	Rather strong.	Faint, but clear.	Extremely faint.	Scarce visible.	—	—

are syrupy nitrates obtained in the preparation of pure ytterbium compounds by decomposing the nitrates partly from the above-named euxenites of Hitterö and partly from other materials of different origins.

(To be continued).

ON A PARTIAL SEPARATION OF THE CONSTITUENTS OF A SOLUTION DURING EXPANSION BY RISE OF TEMPERATURE.*

By Prof. J. W. MALLET, F.R.S.

It was observed in regard to a thermometer containing coloured alcohol, the colour due probably to cochineal, that on several occasions when rise of temperature occurred somewhat gradually in the room after rather severely cold weather, the upper part of the column of liquid was colourless or nearly so, while no deposition of any solid colouring-matter could be seen in the bulb or the lower part of the tube. Colourless alcohol had apparently separated itself by expansion from a still perfect solution left behind.

This led to making some experiments with solutions, partly aqueous, partly alcoholic, of several colloid substances, such as starch, tannin, caramel, albumen, and gelatin. Each solution was placed in a flask of about half a litre capacity, which was brought to near 0° C by being surrounded with ice, filled to the mouth with the solution at this temperature, and closed by a cork traversed by a glass tube of small but not capillary bore (about 4 m.m. interior diameter) 15 or 20 c.m. long, and having a glass stopcock in the middle of its length. The ice having been removed, the temperature of the flask and its contents was allowed to rise gradually in a warm room until the head of the column of liquid in the tube, originally one or two centimetres below the stopcock, had reached to about as far above it. The stopcock was then cautiously closed, and the small portion of liquid above it, removed by means of a capillary pipette, was submitted to appropriate tests for the substance in solution in the contents of the body of the flask. In contrast with a sample of equal volume taken from the flask itself, the

* Read before the Chemical Section of the British Association, Manchester Meeting.

b. Euxenite from Arendal (continued).

Intensity of the Absorption-bands of the Several Fractions.

VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Medium strong.	Rather faint.	Rather faint.	Faint.	Very faint.	Extremely faint.	—	—
—	Extremely faint.	Very faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	—
Rather strong.	Rather strong.	Strong.	Strong as Er line λ=6547.	Stronger than 654 7.	Strong.	Strong.	Strong.
—	—	—	—	—	—	—	—
Strong.	Strong.	Strong.	Rather strong.	Rather strong.	Rather strong.	Rather faint.	Faint.
Extremely faint.	Very faint.	Very faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Very faint.	—	—	—	—	—	—	—
Scarce visible.	—	—	—	—	—	—	—
Stronger than 536·3.	Strong.	Strong.	Strong.	Rather strong.	Rather faint	Faint.	Very faint.
Rather strong.	Rather faint.	Faint.	Faint.	Very faint.	Extremely faint.	—	—
Very strong.	Strong.	Strong.	Strong.	Strong.	Strong.	Strong.	Strong.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Strong.	Strong as X λ=452·6.	Very strong.	Fainter than 452·6.	Rather strong.	Rather strong.	Rather strong.	Rather strong.
—	—	—	—	—	—	—	—
Rather faint.	Faint.	Very faint.	Extremely faint.	—	—	—	—
Faint.	Faint.	Very faint.	—	—	—	—	—
—	—	—	—	—	—	—	—
Extremely strong.	Extremely strong.	Very strong.	Strongest line.	Strong.	Very strong.	Rather strong.	Very faint.
Faint.	Faint.	Faint.	Faint.	Faint.	Very faint.	Extremely faint.	—
Very faint.	Extremely faint.	—	—	—	—	—	—
Strong.	Rather strong.	Faint.	Extremely faint.	—	—	—	—

portion which had been slowly driven up by expansion was found to contain a diminished amount of material in solution, often a very notably diminished amount, and in two or three instances practically none.

All the solutions tried were filtered beforehand through four thicknesses of fine close filtering paper, so as to remove suspended particles of solid matter. No film consisting of, or rich in, the material dissolved in the bulk of the liquid could be detected on the inner surface of the tube in its upper part, so that the separation could not well be attributed to surface adhesion.

The extent of exposure to the air on the small cross-section of the tube would hardly allow of an explanation being found in chemical change of the dissolved material.

The term apantlesis (ἀπάντλησις) might be used to signify a draining away of some of the molecules of the solvent undergoing expansion from amongst those of the colloid solid in solution. Such draining away would seem to connect itself on to change in the opposite direction, but leading to the same result, when the colloid begins to separate out by gelatinising on cooling.

The conditions which seemed most to influence the production and the distinctness of the phenomenon were—first, the proportion of the colloid solid in solution; and second, the time occupied in the rise of temperature of the liquid. In regard to each of these conditions, there appeared to be a certain point at which the separation was most notable, above or below which it became gradually less distinct, and sufficiently removed from which it was not observable at all.

ON ORGANIC VANADATES.*

By JOHN A. HALL, Owens College.

I HAVE obtained a series of organic ortho-vanadates by the action of an alkyl bromide on silver ortho-vanadate.

* Read before the Chemical Section of the British Association, Manchester Meeting.

These bodies are yellow liquids, which decompose on distillation under the ordinary pressure, but the lower members can be distilled under reduced pressure.

Methyl vanadate could not be obtained.

Ethyl vanadate boils at 150° C. under a pressure of 120 mm. The vapour density is normal. The specific gravity is 1·167 at 17·5° C.

The refractive indices are—

For	1·473
„ Sodium	1·481
„ Thallium	1·483

Amyl pyro-vanadate is the only pyro-vanadate which I have been able to obtain in sufficient quantity for analysis.

No meta-vanadates could be obtained, an ether and vanadium pentoxide always being formed.

All these organic vanadates are immediately decomposed by water, with the formation of vanadic acid, thus resembling the organic arsenates more closely than the phosphates.

As I was unable to prepare methyl vanadate, I tried the action of methyl iodide on silver phosphate, and obtained methyl phosphate, a colourless liquid, boiling at 190° C. (uncorrected).

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 135).

Carbhydrate Filtrate.

A PORTION, representing a certain volume of the *aqueous extract*, of the *carbhydrate filtrate* was evaporated, dried,

* Reprinted from the *Transactions of the American Philosophical Society.*

and weighed. It yielded 7·65 per cent of the total solids of the *aqueous extract residue*. A known weight of the *carbhydrate filtrate residue* was dissolved in water and heated over a water-bath with Fehling's solution, and the amount of glucose present estimated gravimetrically from the weight of the cupric oxide. It was estimated as 4·47 per cent. Another portion of the *carbhydrate filtrate residue* was boiled with 83 per cent alcohol. A precipitate formed on cooling, which was collected on a weighed filter, dried, and weighed. It yielded 1·98 per cent. The 83 per cent alcohol precipitate was identified as saponin by the usual tests. The *carbhydrate filtrate residue* was precipitated by acetate of lead and the precipitate examined qualitatively for organic acids. The lead precipitate was decomposed by sulphuretted hydrogen and filtered, and the filtrate concentrated over a water-bath, and mixed with lime-water until turbid. The turbidity did not clear on adding dilute acetic acid.

The *aqueous extract* was examined for tannin, and with negative results. Calcium oxalate was present.

Extract (3), *the Green Part of the Leaf.*

The residual powder was dried from all traces of alcohol, and cold distilled water was allowed to slowly percolate through the powder. The *extract* was coloured, and slightly acid in reaction. A definite volume of the *extract* was evaporated, dried, and weighed, and the ash calculated from incinerating a known weight of the *residue*.

Total Solids.

	Per cent.
Aqueous residue dried between 100° C. and 110° ..	4·35
„ „ ash	0·40

Gum.

One volume of the *aqueous extract* was mixed with two volumes of stronger alcohol. The precipitate was collected after twenty-four hours, washed with 66 per cent alcohol, dried, and weighed. The precipitate and filter were incinerated, and the ash estimated.

	Per cent.
Weight of precipitate by stronger alcohol yielded	0·775
„ „ ash yielded	0·125

Carbhydrates.

The gum filtrate and wash alcohol were concentrated at a low temperature, and the residual liquid mixed with four volumes of stronger alcohol. The resulting precipitate was rapidly filtered and collected. The percentage of *carbhydrates* was estimated gravimetrically from a copper solution in the usual way. It amounted to 0·525 per cent.

Carbhydrate Filtrate.

The *filtrate* was evaporated to dryness. A part of the *residue* was boiled with 83 per cent alcohol. On cooling, a precipitate formed. It was identified by the usual tests as saponin. Another portion of the *residue* was precipitated with the basic acetate of lead. The lead precipitate was decomposed by sulphuretted hydrogen, the solution filtered, and the filtrate evaporated over a water-bath until all odour of sulphuretted hydrogen was dissipated. A part of the lead sulphide filtrate was mixed with lime-water, and a precipitate formed not completely dissolved by acetic acid. The remainder of the lead sulphide filtrate was allowed to evaporate over sulphuric acid. The residue consisted of a mass of fine crystals radiating from a centre.*

The crystals gave a very acid reaction when placed on moistened blue litmus-paper. They turned black and left a residue when heated on platinum foil, and the residue was slowly dissolved by nitric or hydrochloric acid. The quantity of residue was very small, and no effervescence was observed. The melting-point of the crystals was taken. A small quantity was placed in a tube with thin walls, and gradually heated; at 150° C. the substance sublimed, leaving a white cloudy stain on the inner surface of the tube; at 190° C. this cloudy stain changed to a pale green spot, and with increasing temperature to 210° C. no further change was noted. Dry sodium carbonate was added to an aqueous solution of the crystals, and a slight effervescence was observed. Some iron was separated which possibly was in combination with the crystalline principle. Negative results followed tests for formates, acetates, malates, tartrates, citrates, phosphates, oxalates, alkaloids, and glucosides.

The amount of glucose present in the *aqueous extract* was too small to determine quantitatively. Negative results for tannin.

Extract (4), *the Yellow Base of the Leaf.*

The residual powder from the alcoholic maceration was dried and replaced in the percolator. Cold distilled water was allowed to percolate slowly through the powder. The *aqueous extract* was slightly acid in reaction. A known measure of it was evaporated, dried, and weighed. The ash was determined from a part of the *aqueous extract residue*.

Total Solids.

	Per cent.
Aqueous residue dried between 100° and 110° C. ..	11·35
„ „ ash	3·10

Gum.

One volume of the *aqueous extract* was mixed with two volumes of stronger alcohol. The precipitate was collected, washed with 66 per cent alcohol, dried, and weighed. The ash was calculated from incinerating the precipitate, and deducting the filter.

	Per cent.
Weight by precipitate by stronger alcohol yielded	3·850
„ „ ash yielded	0·676

Carbhydrates.

The filtrate and wash alcohol from the gum precipitate were concentrated at a low temperature. The residual liquid was mixed with four volumes of stronger alcohol, when a precipitate formed, and was rapidly filtered off. The *carbhydrates* were dissolved in water, boiled with dilute acid, and the liquid rendered alkaline and heated over a water-bath with Fehling's solution. The amount of carbhydrates was estimated gravimetrically in the usual way. It gave 2·95 per cent.

Carbhydrate Filtrate.

The *filtrate residue* was examined for glucose, and traces of it were present. The *filtrate residue* was precipitated with acetate of lead, and the lead precipitate was dissolved in water and decomposed by sulphuretted hydrogen. The lead sulphide filtrate was tested qualitatively for organic acids, and a turbidity formed on adding to the filtrate lime-water. It was not completely cleared by acetic acid.

Negative results followed tests with alcoholic methyl-violet solution for mineral acids. The *aqueous extract* contained no tannin. Calcium oxalate was determined in it.

AQUEOUS MACERATION AT A TEMPERATUKE OF 50° C. TO 60° C.

The Bark of the Root (1), *the Wood of the Root* (2).

The powder (1) used in the cold water extraction was macerated with distilled water heated between 50° and 60° C. The *warm aqueous extract* (1) was cooled and mixed with three volumes of stronger alcohol. A precipitate formed, it was dried, weighed, and the percentage estimated. It yielded 0·03 per cent.* The precipitate

* The material used in this analysis of the green part of the leaf was quite dry and powdered readily. A previous examination of the *fresh leaves* gave more satisfactory quantitative results. A gum was extracted which promises to be of interest for a future study, and the crystals separated from the lead sulphide filtrate are to be further investigated

* *Examination for Inulin*, page 87, Plant Analysis, G. Dragendorff. English translation.

was dissolved in warm water. On evaporating the filtrate, a white residue was obtained. It was stained yellow by iodine.

The powder (2) from the cold water treatment was macerated in the warm water. The *warm aqueous extract* (2) was a dark coloured liquid, indicating a colouring matter. A certain measure of the *extract* was evaporated, and the solids estimated. It amounted to 4 per cent. The percentage of solids precipitated from the *extract* by stronger alcohol was 0·25 per cent.

(To be continued).

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

Sir,—In the article on the manufacture of butterine by Mr. Thomas T. P. Bruce Warren, which appears in the Chemical News, vol. lvi., p. 133, I observe that the author is apparently unaware that sesame oil is already largely employed in the manufacture of butter substitutes, which I suppose for the future we must call "margarine." In America, cotton-seed oil is doubtless the fluid oil chiefly employed for the purpose in question, but I believe this is not the case in Europe, where sesame oil and arachis oil seem to be preferred.

As Mr. Warren refers in his article to a communication on the "Adulteration of Oils," which he contributed to the Chemical News, vol. lv., p. 134, it may not be out of place to comment on some of the statements made in that paper, which otherwise lapse of time might induce me to pass over.

Mr. Warren commences his paper on the adulteration of oils by the statement that "with a few trifling exceptions all that appears from time to time in our chemical journals may be found in Chateau's "Corps Gras Industriels" (1864) and Fontenelle's "Manuel d'Huiles" (1866).

Among the methods of examining oils which Mr. Warren appears to class among "a few trifling exceptions" are the following:—

1. The process of determining the free fatty acids in oils by titration in alcoholic solution with phenol-phthalein as an indicator, as devised by Hausemann.

2. The method of ascertaining the saponification-equivalents of oils, devised by Koettstorpe.

3. The method of examining butter and similar fats containing glycerides of lower fatty acids, devised by Hehner.

4. The method of determining the volatile acids of butter and others, devised by Reichert.

5. The method of separating fatty and resin acids, invented by Gladding.

6. The determination of the bromine-absorptions of oils by Mills, and of iodine absorptions by Hübl.

7. The improved methods of determining the specific gravity of fats devised by Bell, Estcourt, and others.

8. The many quantitative determinations of the rise of temperature on treating oils with strong sulphuric acid in the manner described by Maumené.

9. The improved methods of determining glycerin, devised by Morawski, Muter, Benedikt, Fox, and others.

10. The determination of the higher alcohols in sperm and bottle-nose oils, and of hydrocarbon oils in fatty oils generally.

All, or near all, of the foregoing methods of examining oils have been devised or perfected within the last twenty years, and the majority of them within the last eight or ten, and hence could not have been described, or even foreshadowed, in books published in 1864 and 1866.

While apparently unaware of the enormous amount of work done, and the numerous quantitative results recorded by the chemists mentioned above, and by those who have employed their methods, Mr. Warren recommends the employment of chloride of sulphur as a qualitative test for oils. I had occasion to make some experiments with this reagent a few years since, but for another purpose than that of detecting or identifying any particular oil.

My experience of chloride of sulphur leads me to believe it to be badly adapted for such a purpose, as in my hands the extent and rapidity of its action on an oil varied in an obscure manner under conditions apparently identical. However, if Mr. Warren will prescribe definitely the method in which he prefers to employ chloride of sulphur as a reagent for oils, there are many chemists who, like myself, will be only too glad to give it a careful trial. Unfortunately, in his article he gives no such particulars as would enable other chemists to employ the reagent to the best advantage, and hence we look forward with interest to the publication by Mr. Warren of further information on the subject.—I am, &c.,

Alfred H. Allen.

Sheffield, Sept 24, 1887.

COLOURED FIRES.

To the Editor of the Chemical News.

Sir,—If "Practical Chemist" will refer to Kentish's "Pyrotechnist's Treasury" (London: Chatto and Windus) he will find no less than seventy-five formulæ for coloured fires which contain calomel.

Many, but not all, of these formulæ include also copper sulphide, and it is stated (p. 178) that the mercury salt is used as a source of chlorine, in which compounds of copper burn with a blue colour. The mercurous chloride is in these cases, no doubt, used, notwithstanding its cost, because of its superior stability and non-deliquescence, and because there is no solid residue as a product of its combustion.

It does not, however, seem quite clear why calomel should be used in the absence of copper, as in some of Kentish's formulæ and in that cited by your correspondent, but it is perhaps because of the intense light produced by the combustion of mercury at high temperatures.

The subject seems sufficiently interesting, and perhaps some practical pyrotechnist who is also a chemist will come to the rescue.—I am, &c.,

Harry Napier Draper.

Esterel, Temple Road, Upper Rathmines, September 24, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 8, August 22, 1887.

Compressibility of Certain Solutions of Gas.—F. Isambert.—Very soluble gases, such as ammoniacal gas, give solutions which seem, by certain of their characters, to differ totally from true compounds. The author has sought to obtain new data on this question by a study of the physical properties of these solutions, and in the first place of their compressibility. He finds that a simple solution of gas alters little the coefficient of solubility of the solvent, and that the solution of ammoniacal gas in water behaves like the solution of a true chemical compound.

On the Zinc Titanates, and especially on a Tri-titanate.—Lucien Lévy.—Zinc trititanate is an acicular body, steel grey, inclining to a violet, of the sp. gr. 4·92 at 15°; insoluble in water, alcohol, and ether; infusible before the blowpipe. Heat transforms it, without loss of

weight, into a greenish mass. Hydrogen does not attack it at a red heat. Dilute sulphuric, hydrochloric, and nitric acids do not attack it, even in heat. Boiling sulphuric acid attacks it with difficulty. Strong boiling alkalies have no action; melting potassa attacks it; acidified hydrogen peroxide takes a characteristic yellow colour on contact with this compound, but the attack is never complete.

No. 9, August 29, 1887.

Projection-Saccharimeter. — Leon Laurent. — The construction of this instrument cannot be made intelligible without the accompanying diagram.

Experiments in Agricultural Chemistry.—J. Raulin. —The author considers that the results of comparative trials in agriculture are almost always disturbed by the influence of the unequal fertility of the soil at different points. This influence is sometimes as great as that of the conditions to be studied. To avoid this cause of error the experiments at the agronomic station of the Rhone are arranged as follows:—The rectangular experimental field is divided into as many rectangular plots, equal and parallel, as there are conditions to be studied. Each of these plots is divided into three equal squares, A, B, C. The two extreme squares, A and C, are treated identically, whilst B serves as a check. In general the natural fertility of the soil presents differences from A to C. If they are absolutely irregular the ground is not fit for comparative trials. But more commonly the fertility increases or decreases regularly from A to C, so that half the sum of the crops of A and C would be equal to the crop of B, if all three were similarly treated. The cause of error due to the inequality of the soil is thus chiefly eliminated, and the proportion of the crop of $\frac{A+C}{2}$ to that of B expresses the real influence of the manure or other condition which is being studied.

MISCELLANEOUS.

King's College, London.—Lectures on Agriculture. —A Course of about Eighteen Lectures will be delivered on "Agriculture" during the ensuing Winter Session, by Mr. Frederick James Lloyd, F.C.S., F.I.C., Consulting Chemist to the British Dairy Farmers' Association, beginning Friday, October 14, from 6 to 7 p.m. Fee for the Course £2 2s., payable in advance in the College Office. *Syllabus*:—Soils: Composition and Properties of Soils; The Atmosphere and Soil as Plant Food; Cultivation of the Soil; Improvement of the Soil Drainage, Subsoiling, &c. Manures: Farmyard Manure and its Treatment; Artificial Manures, their Composition and profitable Application. Crops: Chemistry and Physiology of Plant Life; The Rotation and Treatment of the principal Farm Crops; The Composition and value of Agricultural Produce. Live Stock: Chemistry and Physiology of Animal Life; The Rearing and Management of Live Stock; The Production of Animal Food; Dairy Management and Produce. The Lectures will be especially adapted to prepare Students for the Examinations of the Royal Agricultural Society, and of the Surveyors' Institute.

ERRATUM.—In the summary of the classes at the Manchester Technical School, in our last issue, the second year's course of lectures should have read "Lectures upon the *rarer* metals," &c.

UNIVERSITY COLLEGE, LIVERPOOL.

The SHERIDAN MUSPRATT CHEMICAL SCHOLARSHIP, of the value of £50 per annum, tenable for two years, is awarded after an Examination commencing on December 8th. and is open to any Candidates under 23 years of age.

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Full particulars can be obtained from the Registrar, Normal School of Science, South Kensington, and Prospectuses at the Catalogue Sale Stall of the South Kensington Museum.

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SESSION 1887-88.

FACULTIES OF ARTS AND SCIENCE.

The NEXT SESSION commences on MONDAY, October 3rd.

No Student will be admitted under the age of 16 without having passed a Preliminary Examination.

SYLLABUSES, containing complete information as to the various Courses of Instruction, Fees, Lecture Days and Hours, Entrance and other Scholarships, Prizes, &c., may be obtained from CORNISH BROS., New Street, Birmingham, price 3d., by post 4½d.

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PROFESSOR—SYDNEY YOUNG, D Sc.
LECTURER—ARTHUR RICHARDSON, Ph.D.

The SESSION 1887-88 begins on 4th OCTOBER. Lectures on Inorganic, Organic, Advanced, and Photographic Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening Lectures on Inorganic Chemistry and on Photographic Chemistry at reduced fees are delivered. There will also be a Course of Lectures on the Chemistry of Every-day Life. Several Scholarships are tenable at the College. Calendar, containing full information, price 1s. (by post 1s. 3d.). For Prospectus and further information apply to the Registrar.

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DEMONSTRATOR AND ASSISTANT LECTURER IN CHEMISTRY. Stipend £120 a year.

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The above appointments are now vacant. Applications, together with testimonials, must be sent in on or before Saturday, October 8th, 1887, to the undersigned, of whom all further particulars may be obtained.

IVOR JAMES,
Cardiff, September 6, 1887. Registrar.

SALT ROYALTY.

TO LET.—The Owners of the Middlesbrough Estate, Limited, are prepared to receive offers, or enter into negotiations for working, the Bed of Rock Salt which has recently been proved to be under the Company's Estate, 90 feet in thickness, at a depth from the surface of 1340 feet. The site of the Bore-hole which has been sunk is in close proximity to the Guisbrough Branch of the North-Eastern Railway, and within a short distance of the Middlesbrough Docks and the River Tees. There are several acres of land adjoining, suitable for the erection of Works.

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LABORATORY.—Wanted Immediately, Laboratory for Technical Research for two to work in. Will be required for a month or more.—Apply to V. J., Ashurst, West Hill, Sydenham.

THE CHEMICAL NEWS.

Vol. LVI. No. 1454.

THE RELATION OF SCIENCE TO THE STATE.

III.

Having in our last issue endeavoured to show the importance of scientific research to nations, we have to encounter the main questions—Is the present position of Science in the United Kingdom satisfactory? and if not, why not? To the former of these queries scarcely anyone has the boldness to reply in the affirmative. Were all well with us in this respect, why that feeling of dissatisfied excitement rarely felt on any subject which does not fall within the programme of faction? Why do we send out commissions to scrutinise the state of scientific and technical education in Continental countries? Why do we institute new colleges and training schools of different grades, and why propose, as it has been lately done, new Parliamentary action in this direction? Why do we hear complaints made, not merely at the gatherings of purely scientific bodies, but among men of business, that in this important respect and in comparison with rival nations we are not holding our own, not to speak of gaining ground?

That along with this feeling of discontent and this craving for improvement there is an undercurrent of indifference, or even of hostility to Science, is but too true. Why, else, should Sir Henry Roscoe, in his late presidential address before the British Association, remark that Science was less respected in Britain than in other civilised countries? Or how could a well-informed German contemporary take occasion to say that Britain had, whichever party happened to be in power, "a Government very unfavourably disposed to Science and to her disciples"? ("Eine der Wissenschaft und ihren Jüngern sehr abhold gesinnte Regierung)".

In fact, notwithstanding all that has been done of late years, all the efforts made, and all the money expended, many of the complaints urged in Babbage's "Decline of Science" still hold good. It can no longer, indeed, be said that there is in all the universities of Britain not a single person engaged in any train of original research. We recognise with pleasure that experimental Science has obtained a footing in our ancient seats of learning, and that fairly efficient laboratories—chemical, physiological, and biological—have been or are being organised. Whether these institutions, when compared with those met with abroad, *e.g.*, at the University of Strasburg, are fairly commensurate with the importance of their task and with the wealth of the country, is another question.

But we have still to complain of the paucity of research issuing from the British Universities. We have tilled and manured the soil, and scattered the good seed, but the harvest, so far, is of the scantiest. We take up some German chemical journal, say a number of *Liebig's Annalen* or the *Journal für Praktische Chemie*, and looking down the table of contents we see such headings as these—"Communications from the Chemical Laboratory of the University of Leipzig, of Bonn, of Würzburg," &c., thus showing that in these institutions original research is being actively and successfully conducted. We single out here chemistry both as being, in our belief, the most important of the Sciences, and as being our special and immediate subject. But in the other Sciences the case is the same: every German, Austrian, Swiss, even Russian university is a copious well of scientific truth, not a mere cistern in which such truth is stored up. Now can we present any similar spectacle in Britain? Can we, *e.g.*, in the Chemical News, lay before our readers every few months a summary of chemical researches carried on in the Universities of Oxford, Cambridge, Edinburgh, Glasgow, or Dublin?

But it may, perhaps, be thought that if original research does not flourish as it ought in our universities, it finds other channels. What of our numerous learned societies, and of the papers sent for insertion to our scientific journals? Here we may boast of a goodly amount of work done, some of which is unsurpassed in value. But in quantity it must, we fear, be admitted that we cannot stand the test of a comparison with Germany. Confining ourselves here to chemistry, we see the *Berichte* of the German Chemical Society issued yearly in not fewer than twenty parts, each of which contains on an average forty original memoirs. There are, in addition, *Liebig's Annalen*, the *Journal fur Praktische Chemie*, entirely filled with original matter, and a number of other Journals, which, along with abstracts and articles on various branches of technical chemistry, bring forward no small quantity of original research.

It will be said that the German Journals aforesaid receive their matter not merely from the German Empire, but from Sweden, Holland, Belgium, Austria, Russia, and even to some extent from England. Precisely; but wherefore do non-German *savants* thus select German Journals and Transactions as the channel for their discoveries? Very rarely are English Journals thus favoured. The reason, surely, is not hard to divine. Many scientists in all parts of the world have been trained in the German Universities, or have studied in their own countries under German Professors. But how many aliens flock to Britain to study in our universities? How many Englishmen are called to fill professorial chairs in foreign countries? Nay, under present circumstances we seem unable to produce competent men in sufficient numbers for scientific professorships in the Colonies, in India, and even at home. The number of aliens who thus occupy prominent positions in our colleges, museums, observatories, &c., is nothing short of a national stigma, and is alone sufficient to demonstrate the unsatisfactory position of Science among us.

The number of scientific works which issue from the British press is also no satisfactory feature. With the exception of translations, and of manuals and crambooks, we are not fertile. In the latter department we are, by way of contrast, only too rich.

Another proof of our shortcomings may be found in the rarity of our scientific exploring expeditions, by land or by sea. Since the memorable voyage of the *Challenger* nothing of an extensive systematic character has been undertaken either under the auspices of Government or of private individuals. Nor must we forget that the staff of the *Challenger* was in part recruited abroad, and that the collections made and other crude results obtained were not entirely worked out at home. Some of them were committed for this purpose to Prof. Bary, of the University of Strasburg.

The last, and certainly not the weakest, evidence of the state into which we have allowed ourselves to fall is the continued influx of foreigners into the laboratories of our chemical manufactories. Exact statistics on this point do not seem to be procurable; but as far as the observation of individuals can reach, these foreigners are continually increasing in number. About the year 1858 there was, to the best of our knowledge, only one foreign chemist employed in the great alkali district of south-west Lancashire; now, we believe, they are more numerous than native chemists. At the risk of a momentary digression we may pronounce it singular and unfortunate that such an increase should have been effected in the very teeth, so to speak, of the Science and Art Department, with its great powers and its lavish expenditure.

TORSION BALANCES.*

By Dr. A. SPRINGER.

Light frames are made and stiffened by wires or flat bands being tensioned over them. The beam is then firmly clamped to the bands in such a manner that its centre of gravity is above its point of support; this tends to tip the beam, thus equilibrating the torsional resistance of the fulcrums. We thus have the torsional resistance exerted to keep the beam horizontal, and the high centre of gravity tends to tip it out of the horizontal.

The adjustment of the position of the centre of gravity is most easily made by having an adjustable poise placed immediately above the centre of the torsional wire. In order to do away with the necessity of alignment of support a secondary beam is attached to the first in such a manner that both beams tending to tip in the same direction remain stationary owing to their having opposite and equal moments.

On this principle, scales are constructed which can be used on rolling ships or in buildings where there is considerable jarring. In all the "Torsion Balances" there is permanence of adjustment, consequently repeated weighings will give like results.

Various "Torsion Balances" were shown illustrating the principles involved, as well as to show how equal sensitiveness can be obtained with any load.

APPARATUS FOR MEASURING THE VOLUME OF GAS INVOLVED IN VARIOUS CHEMICAL ACTIONS, WITH OR WITHOUT THE APPLICATION OF HEAT,

With Proposed Extension to Organic Analysis, and to the Continuous Determination of Abnormal Vapour Densities.*

By F. W. WATKIN, M.A.

The apparatus consists of generating tubes, flasks, and U measuring tubes, in direct communication with the generating tubes; the measuring tubes contain water, and readings are taken with the water at the same level in the two branches of each U-tube, so that the readings are all at the barometric pressure. To correct for change of temperature, if at the time of making the final readings the temperature of the room should not be the same as at the time of the initial readings, by the side of the generating tube flasks, measuring tubes, &c., an exactly similar piece of apparatus is placed, consisting of tube, flasks, measuring tubes, &c., and having approximately the same volume as the original piece of apparatus.

The process employed was shown at the meeting of the Association, and the proposed method of application to organic analysis, by which CO_2, H_2O, and N may be concurrently determined, and to abnormal vapour densities, was explained with the assistance of diagrams.

ON SOLUTION.*

By WILLIAM DURHAM, F.R.S.E.

The object of this paper is to show that thermo-chemical results accumulated of late years entirely support the theory of solution which the author brought forward in a paper read before the Royal Society of Edinburgh in January 1878, and developed in subsequent papers.

That theory may be briefly described as follows. Solution is due to the chemical affinity of the elements of the substance dissolved for the elements of the solvent. For instance, common salt, Na_2Cl_2, dissolves in water because of the affinity of Na_2 for O and of Cl_2 for H_2. Further, chemical affinity is not in all cases exhausted when definite compounds are formed, but sufficient remains to form what may be called "solution compounds."

In support of this view it is pointed out that in all chlorides, bromides, iodides, sulphates, and nitrates for which data are available the heat of solution *varies directly*—

(1) As the heat of combination of the positive element of the salt with O in water varies.

(2) As the heat of combination of the negative element of the salt with H varies. And *inversely*—

(3) As the heat of combination of the positive and negative elements of the salt varies. Examples are given, such as the following:—

Compound.	Heat of Combination.	Difference.	Heat of Solution.	Difference.
$[Mg,Cl_2]$ ..	151010		35920	
$[Mg,O,Aq]$ ..	148960			
		2050		
$[Ca,Cl_2]$ ..	169820		17410	
				+18510
$[Ca,OAq]$ ..	149260			
		20560		
		−18510		+18510
$[Na,Cl]$	97690		−1180	
$[H,Cl,Aq]$ ..	39315			
		58375		
$[Na,Br]$	85770		−190	
				−990
$[H,Br,Aq]$ ..	28380			
		57390		
		+985		−990

The author further shows that if we take two salts, say chlorides, in one of which the heat of combination is greater than in the other, we find that the difference appears in the increased heat of solution of the latter, modified by the difference of affinities of the metals for O; as for example:—

Difference of Heats of Combination.		Difference of Heats of Solution.
$[K_2,Cl_2] - [Li_2,Cl_2]$ = 23600		$[Li_2,Cl_2] - [K_2,Cl_2]$ = 25760
$[Li_2,O,Aq] - [K_2,O,Aq]$ 1960		
25560		25760

Also in comparing chlorides with bromides it is found that the excess of heat of combination of the two salts over that of their respective acids varies inversely as the heat of solution of the two salts; thus—

Difference of Heats of Combination.		Difference of Heats of Solution.
$[Ba,Cl_2] - [H_2,Cl_2,Aq]$ 116110		$[Ba,Br_2] - [Ba,Cl_2]$ 2910
$[Ba,Br_2] - [H_2,Br_2,Aq]$ 113200		
2910		2910

Finally, by taking pairs of any salts, every consideration but heats of combination on the one side and heats of solution on the other can be eliminated; and it is evident the heats of solution just vary inversely with the heats of combination; as, for instance—

Difference of Heats of Combination.		Difference of Heats of Solution.
$[Mg,S,O_4] - [Mg,Cl_2]$ 151300		−15640
$[Zn,S,O_4] - [Zn,Cl_2]$ 132860		+ 2800
+18440		−18440

In considering how the absolute amount of heat of solution arises, the author shows that it seems to be due to a balancing of affinities among the constituent elements, and that when, for instance—

$$[M,Cl_2] - \{[M,OAq] + \text{Neutr.}\}$$

* Read before the Chemical Section of the British Association, Manchester Meeting.

is equal to $[H_2,Cl_2,Aq]-[H_2,O]$ there is no heat of solution, and the salt is insoluble. Several examples of chlorides and other salts are given. It would appear also that when an oxide is neutralised by an acid solution, and the salt remains in solution, the operation is not complete; either the oxide and the acid are not completely decomposed when we have positive heat of solution, or, on the other hand, the salt and water resulting from the double decomposition are not completely formed when we have negative heat of solution. When both parts are complete we have insolubility. Several examples are given to show this. It is also pointed out in this paper that in the case of sulphates, when the heat of combination of the oxide with sulphuric anhydride is equal to the heat of combination of the metal with sulphur, there is no solubility, but when the former is less than the latter solution immediately appears; thus—

$[SrO,SO_3]$ =99220 [Sr,S] =99220 Salt insoluble.
$[CaO,SO_3]$ =84200 [Ca,S] =92000 Salt slightly soluble.
$[MgO,SO_3]$ =53070 [Mg,S] =79660 Salt very soluble.

The author finally draws attention to the fact that solution is probably a periodic function of the elements.

THE MATRIX OF THE DIAMOND.*

By Professor H. CARVILL LEWIS.

A MICROSCOPICAL study of the remarkable porphyritic peridotite which contains the diamonds in South Africa, demonstrates several interesting and peculiar features.

The *olivine*, forming much the most abundant constituent, is in porphyritic crystals, sometimes well bounded by crystal faces, at other times rounded and with corrosive cavities, such as occur in it in basaltic rocks. It rarely encloses rounded grains of glassy bronzite, as has been observed in meteorites. The olivine alters either into serpentine in the ordinary way, or into an aggregate of acicular tremolite crystals, the so-called "*pilit*," or becomes surrounded by a zone of indigo blue bastite—a new variety of that substance. The olivine is distinguished by an unusually good cleavage in two directions.

Bronzite, *Chrome diallage*, and *Smaragdite* occur in fine green plates, closely resembling one another. The bronzite is often surrounded by a remarkable zone, with a centric, pegmatitic, or chondritic structure, such as occurs in certain meteorites. This zone is mainly composed of wormlike olivine grains, but a mineral having the optical characters of cyanite also occurs in this zone.

Biotite, a characteristic constituent, occurs in conspicuous plates, often twinned, generally rounded, and distinguished by its weak pleochroism, a character peculiar to the biotite of ultra-basic eruptive rocks. It alters by decomposition into the so-called *Vaalite*.

Perovskite occurs in very numerous but small crystals, which optically appear to be compound rhombic twins.

Pyrope is abundant in rounded red grains. Titanic iron, chromic iron, and some fifteen other minerals were also found. Rutile is formed as a secondary mineral through the alteration of olivine into serpentine, being a genesis of rutile not heretofore observed.

The *chemical composition* shows this to be one of the most basic rocks known, and is a composition which by calculation would belong to a rock composed of equal parts of olivine and serpentine, impregnated by calcite.

The *structure* is at the same time porphyritic and brecciated, being one characteristic of a volcanic rock which, after becoming hard, had been subjected to mechanical movements. It is a volcanic breccia, but not an ash or tuff, the peculiar structure being apparently due to successive paroxysmal eruptions. A similar structure is known in *meteorites*, with which bodies this rock has several analogies. A large amount of the adjoining bituminous shale is enclosed, and has been more or less baked and altered. The occurrence of minute tourmalines is evidence of fumarole action.

The microscopical examination supports the geological data in testifying to the igneous and eruptive character of the peridotite, which lies in the neck or vent of an old volcano.

While belonging to the family of peridotites, this rock is quite distinct in structure and composition from any member of that group heretofore named. It is more basic than the picrite porphyrites, and is not holocrystalline like dunite or saxonite. It is clearly a new rock type, worthy of a distinctive name. The name *Kimberlite*, from the famous locality where it was first observed, is therefore proposed.

Kimberlite probably occurs in several places in Europe, certain garnetiferous serpentines belonging here. It is already known at two places in the United States: at Elliott County, Kentucky, and at Syracuse, New York; at both of which places it is eruptive and post-carboniferous, similar in structure and composition to the Kimberley rock.

At the diamond localities in other parts of the world diamonds are found either in diluvial gravels or in conglomerates of secondary origin, and the original matrix is difficult to discover. Thus, in India and Brazil the diamonds lie in a conglomerate with other pebbles, and their matrix has not been discovered. Recent observations in Brazil have proved that it is a mistake to suppose that diamonds occur in itacolumite, specimens supposed to show this association being artificially manufactured. But at other diamond localities, where the geology of the region is better known than in India or Brazil, the matrix of the diamond may be inferred with some degree of certainty. Thus, in Borneo diamonds and platinum occur only in those rivers which drain a serpentine district, and on Tanah Laut they also lie on serpentine. In New South Wales, near each locality where diamonds occur, serpentine also occurs, and is sometimes in contact with carboniferous shales. Platinum, also derived from eruptive serpentine, occurs here with the diamonds. In the Urals, diamonds have been reported from four widely separated localities, and at each of these, as shown on Murchison's map, serpentine occurs. At one of the localities the serpentine has been shown to be an altered peridotite. A diamond has been found in Bohemia in a sand containing pyropes, and these pyropes are now known to have been derived from a serpentine altered from a peridotite. In North Carolina a number of diamonds and some platinum have been found in river sands, and that State is distinguished from all others in eastern America by its great beds of peridotite and its abundant serpentine. Finally, in northern California, where diamonds occur plentifully and are associated with platinum, there are great outbursts of post-carboniferous eruptive serpentine, the serpentine being more abundant than elsewhere in North America. At all the localities mentioned chromic and titanic iron ore occur in the diamond bearing sand, and both of these minerals are characteristic constituents of serpentine.

All the facts thus far collected indicate *serpentine*, in the form of a decomposed eruptive peridotite, as the original matrix of the diamond.

* Read before the Section C of the British Association, Manchester Meeting.

AN ELECTROLYTIC METHOD OF PREPARING METALLIC ALLOYS, &c.

By H. WARREN, Research Analyst.

THE following method of preparing metallic alloys, such as silicides, bronzes, &c., has lately been satisfactorily wrought by the following process, which differs slightly from the manner in which mercury amalgamates or combines with mostly all other elements, owing to its

liquidity. By substituting for the mercury, iron, copper, zinc, &c., these metals may be readily made to combine with the more oxidisable elements, such as silicon, phosphorus, &c., by so arranging the process that the metal employed for forming the alloy, when in a fluid state, is connected with the negative pole of a voltaic series, and in direct contact with the substance containing the element with which it is desired to combine it.

The apparatus employed consists of a deep conical crucible, through the bottom of which is inserted a pointed graphite rod, projecting about an inch within; the remaining portion being protected by passing through an iron tube coated with borax to prevent oxidation when exposed to a furnace heat. The extremity is furnished with a binding-screw or clamp, and connected with the negative pole of the batteries employed, the whole arrangement being heated to the melting-point of the metal employed to form the alloy by the aid of a small furnace. Taking, for instance, the preparation of silicon bronze: having introduced a sufficient quantity of metallic copper into the crucible, add sufficient potassium silico-fluoride to form when melted a layer about 2 inches in depth. A thick platinum wire is arranged so that its point just touches the surface of the melted silico-fluoride (care being taken that the melted copper remains sufficiently low so as not to come in contact with the positive pole or platinum wire, otherwise the action is of course neutralised and the power of the batteries uselessly exhausted). This wire is connected to the positive pole of two large cells of the ferric chloride battery, when an instantaneous action is at once perceptible; dense white vapours of hydrofluoric acid are at once evolved from the platinum wire, the potassium silico-fluoride becomes entirely decomposed, and the whole of the silicon when in a nascent state unites with the metallic copper to form a brittle silicide, which may be converted at once into silicon bronze by the usual method, according to the percentage of silicon present.

Phosphor and other bronzes may also be readily formed by slight alteration.

For the preparation of silicon-eisen the substitution of iron in place of copper is all that is required; the silicon-eisen so employed presents the appearance of ordinary hot-blast silicide.

Native cryolite may also be readily decomposed when in contact with metallic zinc, and by suitable means the zinc may be volatilised, leaving pure aluminium.

Magnesium, and the earthy metals, barium, strontium, and calcium, have as yet not been satisfactorily obtained as alloys.

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 147).

II.

As mentioned in the first portion of this memoir, even during the investigation of the thorite earths, the conjecture occurred to the authors that bodies like Soret's X, thulium, and the present erbium, are not simple chemical elements. In the last decennium the old erbia was supposed to be the oxide of a simple element. We know now that this erbia consists of seven earths,—scandia, ytterbia, thulia, erbia, terbia, Soret's X, and yttria.

From the observations communicated in this memoir the authors consider that they can show with great probability that even those erbium earths whose nitrates give absorption-spectra are not simple bodies, but mixtures of the oxides of different elements. As this is most distinctly perceptible if we follow out the occurrence or the absence of the single holmium lines in the spectra examined, the authors report in the first place:—

1. *On the Components of Holmium, or of Soret's* X.

The nitrate of X, or holmium nitrate as it is termed by Clève, gives, according to Soret's measurements, the following absorption-lines in the clearly visible part of the spectrum:—

λ 753 faint.
640·4 } very characteristic.
536·3 }
485·5
474·5 very faint and misty.
453—449.
430 doubtful.

Instead of λ=430·0, Lecoq de Boisbaudran found λ=427·5. The authors found, almost without exception, λ=428·5, which value is accordingly inserted in the foregoing Tables. This line has been repeatedly characterised formerly as an absorption-line of didymium, and has been inserted in didymium spectra. This is because both didymium and holmium are compound bodies, and their single components may occur together. We may name this band λ=428·5, or preferably one of the bands peculiar to X, for it always occurs on examining a holmium material obtained after several hundred decompositions of the mixed nitrates, and which otherwise contains none of the bands hitherto assigned to Di. Such a material is perfectly free from all didymium earths.

It was further observed that at λ=542·6 a band was almost always visible, such as was otherwise found in the spectrum of the holmium lines; λ=542·6 was recognised in the thorites of Arendal, in the Fergusonites of Ytterby and Arendal, in the euxenites from different localities, and in mother-liquors from different minerals. The substance to which this line belongs always follows in those fractions which are becoming richer in holmium; whence for the present we designate this band, like the other holmium lines, by the symbol X.

Lecoq de Boisbaudran made it known last year that, by means of several hundred fractionations of a holmium material with ammonia and potassium sulphate, he had resolved Soret's X into two elements, holmium—properly so called—and dysprosium. The spectrum of *this* holmium nitrate showed the bands λ=640·4 and 536·3 very strongly and the other X lines faintly, whilst dysprosium nitrate showed the other bands of the holmium spectrum more distinctly. Lecoq de Boisbaudran designates the bands of dysprosium, according to the order of their intensities, as—

Dy α.. .. .. .. λ=451·5
Dy β.. .. .. .. λ=475·0
Dy γ.. .. .. .. λ=756·5
Dy δ.. .. .. .. λ=427·5.

As it appears from the above Table holmium is no unitary body, but it consists of more than two components, de Boisbaudran's holmium and dysprosium are also compound bodies.

If we next consider the spectrum of the earths obtained from the thorite of Brevig, it appears that of all the X lines only that at λ=428·5 was recognised as strong, whilst λ=640·4 and 685·5 appeared very faint; λ=428·5 is the fourth faintest line of the dysprosium spectrum, and is designated by Boisbaudran as Dy δ. If dysprosium nitrate is the nitrate of a unitary body, then if Dy δ is strongly visible (as it is in the spectrum of the Brevig thorite), Dy γ, Dy β, and Dy α must appear the stronger in the spectrum. But this was not the case; X lines could be recognised neither at λ=451·5, nor at 475·0, nor 756·5. The so-called dysprosium consists therefore of at least two bodies, to one of which there belongs (in the nitric solution) only the band λ=428·5, whilst the other produces absorptions at λ=451·5, 475·0, and 756·5. As these lines were not observed in the material from the Brevig thorite, this portion of de Boisbaudran's dysprosium does not occur in this mineral. Likewise, in a didymium material obtained from the cerite of Bastnäs only Dy δ=428·5 was observed of all the lines peculiar to Dy.

Here, therefore, Nature has undertaken the separation of that portion of de Boisbaudran's dyprosium, the presence of which, in the mixture known as Soret's X, occasioned the appearance of the absorption-line at $\lambda=428{\cdot}5$ in the holmium spectrum.

Further, de Boisbaudran's Dyβ line, at $\lambda=475{\cdot}0$, was observed in the material precipitated by potassium sulphate from the solutions of the thorite earths from Arendal, as well as in the mother-liquors obtained in the preparation of pure ytterbia (Series 41—46). But the Dyα line, which should appear stronger if Dyα and Dyβ belong to a unitary body, could not be perceived. That $\lambda=475{\cdot}0$ and $451{\cdot}5$ belong to different bodies appears further from the fact that in the spectra of the fractions obtained from the euxenite of Arendal $\lambda=474{\cdot}5$ rapidly decreases in intensity from Fraction V. to X., and at last entirely disappears, whilst $\lambda=453$—449 (Dyα) was observed extremely strong, as the strongest line in the entire spectrum. $\lambda=474{\cdot}5$ belongs to a nitrate which contains an oxide less basic than the nitrate to which $\lambda=451{\cdot}5$ belongs. The latter seems to occur completely separated from the former, and in relatively large quantities, in the Fractions XI., XII., and XIII., from the euxenite of Arendal. Lecoq de Boisbaudran's lines Dyα, Dyβ, and Dyδ belong therefore to three distinct elements.

As for the X line $\lambda=485{\cdot}5$ it was observed faintly, but certainly, in the spectrum of the thorite of Brevig, and in those of the mother-liquors obtained in preparing ytterbia, whilst the X (or Dy) lines at $\lambda=474{\cdot}5$ and $451{\cdot}5$, or at $\lambda=451{\cdot}5$ and $428{\cdot}5$, could not be seen. The X lines also $\lambda=542{\cdot}6$ and $536{\cdot}3$ were not visible in the spectrum of the Brevig thorite, though $\lambda=485{\cdot}5$ was recognised. If we further consider that $\lambda=485{\cdot}5$ appeared somewhat strongly in the Fractions VI. to IX. of the fergusonite of Arendal, without $\lambda=640{\cdot}4$, $474{\cdot}5$, and $428{\cdot}5$ being visible, it appears that the occurrence of this X line is not necessarily accompanied by that of any other X line, and that the body whose presence occasions the line $\lambda=485{\cdot}5$ must exist in the different minerals and fractions examined, in part separated from the other components of Soret's X.

As regards holmium in the stricter sense of the word, its nitrate gives, according to Lecoq de Boisbaudran, principally only two bands at $\lambda=640{\cdot}4$ and $536{\cdot}3$. But this true holmium must at least consist of two elements, for $\lambda=640{\cdot}4$ was observed in the spectra of thorite of Brevig and in those of the cerite of Bastnäs, certainly though faintly, whilst $\lambda=536{\cdot}3$ was not present. On the other hand, in the spectra of the yttria earths from the thorite of Arendal, in that of wœhlerite, of fergusonite from Arendal, and in the first fractions of euxenite from Arendal, the line $\lambda=536{\cdot}3$ was in part strongly visible without the least indication at $\lambda=640{\cdot}4$ of the element producing this line.

In fine, it is evident that the X line at $\lambda=542{\cdot}6$ was observed without the simultaneous recognition of—

- $\lambda=428{\cdot}5$ (see fergusonite from Arendal, Fractions V. to XI., and mother-liquors from the ytterbia earths, Series 41 to 46).
- $\lambda=453$—449 (see euxenite from Hitterö, Fractions I. and II., and ytterbia mother-liquors, Series 41 to 46).
- $\lambda=474{\cdot}5$ (see fergusonite from Arendal, Fractions VI. to XI.).
- $\lambda=485{\cdot}5$ (see yttria earths from the thorite of Arendal; euxenite from Hitterö, Fractions I. to IV.; euxenite from Arendal, Fractions. I. and II·).
- $\lambda=536{\cdot}3$ (see fergusonite of Arendal, Fractions X. and XI.; euxenite from Arendal, Fractions XIII. and XIV., and ytterbia mother-liquors, Series 41 to 46).
- $\lambda=640{\cdot}4$ (see yttria earths from the thorite of Arendal, fergusonite, some fractions of the euxenite from Arendal, and ytterbia mother-liquors, Series 41 to 46). If the line $\lambda=542{\cdot}6$ actually occurs together with all other X lines (as, *e.g.*, in the fractions of euxenite from Hitterö, or in the spectrum of the holmium material) it appears relatively very weak.

So much the rather must the other X lines, or one of them, always be visible along with $\lambda=542{\cdot}6$ if this line along with another X line was produced by the absorption of a unitary body. But as this is not the case, and as the appearance of $\lambda=542{\cdot}6$ is not connected with the visibility of any other of the X lines, we must ascribe this to the nitrate of a particular element which has the property in common with the other components of holmium that its nitrate has an absorption-spectrum of one line only.

The authors do not, for the present, propose to give especial names to the several components of Soret's X. We abandon the name dysprosium since it denotes merely a compound body. The same holds good with regard to holmium, the more because Clève applies it to the entire X of Soret, whilst Lecoq de Boisbaudran uses it only for a portion of the former. They propose to retain the original name X for Soret's earth, and to distinguish its components as follows:—

Symbol.	Characteristic Line in the Absorption-Spectrum of the Nitrate Solution. λ
Xα	640·4
Xβ	542·6
Xγ	536·3
Xδ	485·5
Xε	474·5
Xζ	451·5
Xη	428·5

There occur in Nature in:—

Minerals.	The Elements.
Thorite of Brevig	Xα, Xδ, Xη
Thorite of Arendal	Xβ, Xγ, Xε, Xζ, Xη
Wœhlerite of Brevig	Xγ, Xζ, Xη
Cerite of Bastnäs	Xα, Xη
Fergusonite of Arendal	All except Xα
Fergusonite of Ytterby and Euxenite of Hitterö and Arendal	All the components.

2. *On the Components of Erbium.*

It having been ascertained about ten years ago that erbium, in the old sense of the word, is a complex body, the name erbium has been applied to a body whose nitric solution, besides a great number of absorption-bands situate in the violet and ultra violet, shows particularly two lines in the visible portion of the spectrum:—

Er$_\alpha$ at $\lambda=523{\cdot}1$ and Er$_\beta$ at $\lambda=654{\cdot}7$.

The former of these lines has been considered as more intense than the latter. The authors give a conspectus of the relative intensities of these two erbium lines in the spectra of the minerals and fractions examined. (See Table next page).

From numbers 1 to 4 of this Table it is evident that the relative intensities of the two erbium bands was found as it has been hitherto given by other authors, $\lambda=523{\cdot}1$, appearing always rather stronger than $\lambda=654{\cdot}7$. It is, however, striking that on examining the holmium material both bands were seen about equally bright. It is still more striking that in the spectra of the thorite of Brevig, of fergusonite of Ytterby, and of the euxenite of Hitterö, the difference between the intensities of the two erbium bands is much greater than in the spectra of the first-mentioned minerals.

If the spectra of the Fractions IV. to VII. of the euxenite of Arendal, $\lambda=523{\cdot}1$, appears very strong, and $\lambda=654{\cdot}7$ strong, then in the spectrum of Fraction I. of the euxenite of Hitterö, in which $\lambda=523{\cdot}1$ is seen extremely strong, $\lambda=654{\cdot}7$ should be found strong or very strong if we have in erbium nitrate (which yields these lines) the nitrate of a chemical element. But this is not the case, since in Fraction I. of the Hitterö euxenite $\lambda=654{\cdot}7$ appears not strong, but extremely weak. We must, therefore, suppose erbium as composed of at least

In the Spectrum of Earths from.	Relative Intensities of Erbium Lines. $\lambda = 654{\cdot}7$.	$\lambda = 523{\cdot}1$.
1. Thorite from Arendal, yttria earths	Rather strong.	Strong.
2. Wœhlerite from Brevig	Rather strong.	Strong.
3. Fergusonite from Arendal { Fract. II. and III. ..	Strong.	Very strong.
„ VI., VII., VIII.	Rather faint.	Rather strong.
„ XII.	—	Very faint.
4. Euxenite from Arendal { Fract. I.	Rather strong.	Strong.
„ IV. to VII.	Strong.	Very strong.
„ X. to XII.	Rather strong.	Strong.
5. Holmium material	Faint.	Faint.
6. Thorite from Brevig	Faint.	Strong.
7. Fergusonite from Ytterby	Rather strong.	Very strong.
8. Euxenite from Hitterö { Fract. I.	Extremely faint.	Extremely strong.
„ II. to VI.	Extremely faint.	Strong.
„ VII. to XLIII. ..	Extremely faint.	Decreasing from rather strong to extremely faint.
9. Mother-liquors from the erbia earths series 54—60	Very faintly visible.	—

two elements,—the nitrate of the one giving the band $\lambda = 654{\cdot}7$, that of the other $\lambda = 523{\cdot}1$. The former body the authors name Er_α ($\lambda = 654{\cdot}7$) and the latter $Er\beta$ ($\lambda = 523{\cdot}1$).

The oxide of Er_α behaves differently from that of $Er\beta$ on a fractionated decomposition of the nitrates. Out of the total quantity of the earths from the Hitterö euxenite there passed into the Fractions I. to XLIII. approximately equal but very small quantities of Er_α, for $\lambda = 654{\cdot}7$ could be distinguished only very faintly in the spectra of all the fractions. $Er\beta$, in accordance with the intensity of $\lambda = 523{\cdot}1$ was present in Fractions I. to VI. in relatively large quantities, but it is met with only in very small quantities in the last fractions of the Hitterö euxenite. This different occurrence of the two bands of so-called erbium in the spectra of these euxenite fractions seems to signify that they cannot belong to the same element. Further evidence in support of this view may be easily found on examining the observations tabulated above.

(To be continued).

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT,

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Concluded from p. 149).

Quantitative Estimation of Saponin.†

The two methods of Christophsohn and Otten for the quantitative estimation of saponin were adopted. The wood of the root was examined.

A.—Ten grms. of the original powder were boiled with distilled water. The saponin was precipitated by baryta-water. After weighing, it was ignited, and the baryta estimated as carbonate, calculated into oxide, and deducted from the weight of the saponin-baryta, the difference being the weight of saponin.

B.—The saponin-baryta was decomposed by acid, and the weight of the sapogenin was ascertained and calculated to saponin.

Several estimations were made on two specimens of the Yucca, collected at different times of the year.

Mean percentage, A .. .. 8·95 per cent.
„ „ B .. .. 10·40* „

The *aqueous extracts* contained gum, albuminous substances, carbhydrates, glucose, saponin, organic acids, calcium oxalate, and no tannin, mineral acids, nor alkaloids. Arabin was not separated from gum (1). Calcium oxalate was brought into aqueous solution possibly by means of the organic acids or saponin. Needle-shaped crystals were found in *extract* (3). They did not respond to tests for formates, acetates, malates, citrates, tartrates, phosphates, oxalates, glucosides, and alkaloids.

Aqueous extracts of 50° C. to 60° C. from the bark and wood of the root contained inulin.

Dilute Caustic Soda Extracts.

Extract (1), *the Bark of the Root.*

The residual powder insoluble in water was suspended whilst moist in a dilute soda solution (0·1 to 0·2 per cent). After twenty-four hours the mixture was filtered. One volume of the filtrate was acidified with acetic acid and mixed with three volumes of 90 per cent alcohol, and allowed to stand in the cool. The precipitate was collected, washed with 75 per cent alcohol, dried, and weighed, deducting ash. It consisted of mucilaginous substances and albumenoids.

	Per cent.
Weight of precipitate by 90 per cent alcohol yielded	0·85
„ „ ash yielded	0·25

Lassaigne's test showed the presence of albuminous substances.

The filtrate and wash alcohol from the 90 per cent alcohol precipitate was evaporated to dryness, and weighed, deducting the amount of soda acetate. It gave 0·24 per cent. The residue soluble in water was mixed with acetate of copper solution. A very small quantity of albuminous substances was precipitated by the reagent.

The albumenoids of the bark were estimated from the total nitrogen in one grm. of the original powder. It yielded 4·75 per cent of albumenoids.

The powder insoluble in dilute soda solution was washed with distilled water. The liquid was deeply

* Reprinted from the *Transactions of the American Philosophical Society.*

† *Loc. cit.*, page 68.

* Examination of the *Yucca angustifolia*, by H. C. De S. Abbott. "The Medical and Surgical Reporter," Sept. 12, 1885, p. 301.

Summary IV. *Aqueous Extracts.*

	Solids extracted.	Ash.	Gum.	Ash.	Glucose.	Saponin. A.	Saponin. B.
1. The bark of the root	4·00 p.c.	2·65 p.c.	2·00 p.c.	0·20 p.c.	traces		
2. „ wood „	12·10 „	1·74 „	1·70 „	0·34 „	4·47 p.c.	8·95 p.c.	10·40 p.c.
3. „ green leaf	4·35 „	0·40 „	0·77 „	0·12 „	traces		
4. „ yellow base of the leaf	11·35 „	3·10 „	3·85 „	0·67 „	„		

coloured. It was evaporated, and the amount of solids estimated. It gave 1·3 per cent.

Extract (2), *the Wood of the Root.*

The powder insoluble in water was treated in the same way as in *extract* (1). The filtered solution was mixed with 90 per cent alcohol in the manner described. The precipitate was estimated, deducting ash.

	Per cent.
Weight of precipitate by 90 per cent alcohol yielded	2·170
,, ,, ash yielded	0·256

The filtrate from the 90 per cent alcohol precipitate was treated with water, and the soluble matter precipitated by copper acetate. The precipitate was collected, dried, weighed, and ignited, the resulting oxide of copper being deducted. It yielded 0·104 per cent of albumenoids. A current of washed carbonic acid was passed through the *dilute soda extract* to determine the presence of globulin (vitellin, myosin), and with negative results. The albumenoids were determined from the total nitrogen in the powdered wood. It amounted to 4·75 per cent. The total albumenoids in the leaves gave 9·62 per cent.

DILUTE HYDROCHLORIC ACID EXTRACTS.

Extract (1), *the Bark of the Root.*

The powder insoluble in dilute soda was washed with water and suspended in water containing 1 per cent of hydrochloric acid. The absence of the blue colour which the starch granules assume when treated with iodine solution was determined by examining the bark under the microscope; and consequently it was not looked for in the *extract*. A qualitative test showed the presence of calcium phosphate, and calcium oxalate. A measured quantity of the *filtrate* was neutralised with ammonia and mixed with three volumes of 90 per cent alcohol. The precipitate was collected on a weighed filter, washed with 60 per cent alcohol, dried, and weighed. It was incinerated, and the ash deducted from the precipitate.

The precipitate yielded	5·20 per cent
,, ,, ,, of ash	0·98 ,,
Organic substance	4·22 ,,

The filtrate from the 90 per cent alcohol precipitate was evaporated. The residue was composed of ammonium chloride, from the reagents employed, and an organic substance having an odour like gum benzoin. It was agitated with ether and on evaporating the solvent a white residue with an odour like benzoin was obtained. Sulphuric acid gave a red colour with it. The amount of this substance was calculated. It gave 0·45 per cent.

Extract (2), *the Wood of the Root.*

The insoluble powder from the dilute soda maceration was washed with distilled water, and suspended in water containing 1 per cent of hydrochloric acid. The same means were used as in *extract* (1) to determine the absence of starch in the wood of the root. Parabin was also absent. Calcium oxalate was detected by qualitative tests. A similar method, as employed for its estimation in extract (1), was used to determine it quantitatively.

The precipitate yielded	0·305 per cent.
,, ,, ,, of ash	0·155 ,,
Organic substance	0·150 ,,

Extract (3), *the Green Part of Leaf.*

The powder used in the dilute soda maceration was washed with distilled water and suspended in water containing 1 per cent of hydrochloric acid. Iron and calcium phosphate were detected in the extract. The leaves were examined under the microscope, and a blue colour was developed by an aqueous solution of iodine, indicative of starch granules. Starch was also present in the yellow base of the leaves.

In my paper on the "Chemical Study of *Yucca angustifolia*," read at Ann Arbor, Mich., I stated what methods I had employed to separate saponin, and the properties of the compound as observed in that plant. Since which time a further study of it has induced me to withhold the notes used at Ann Arbor, from this, and to offer them, with those collected later, in a separate and more complete publication (See Table below).

I am indebted to Dr. F. M. Endlich, for his courteous consideration and kindness in selecting and forwarding the fine specimens of *Yucca* which were used in these analyses, and which were grown in the neighbourhood of Lake Valley, New Mexico. Within a few weeks I have received, in addition, several hundred pounds of the plant from Dr. Endlich.

The investigations described in the preceding pages were conducted in the chemical laboratory of the Philadelphia College of Pharmacy, from February to August, 1885.

PERCENTAGE OF ASH IN BONES OF DIFFERENT AGES.

By WILLIAM P. MASON.

REFERRING to "Watts's Dictionary of Chemistry," under the subject "Bone," we find two tables of analyses of bones, one by Von Bibra and the other by Frémy. These two scientists do not arrive at the same conclusion. Von Bibra states that:—"The portion of inorganic matter in bone is smaller in youth than in age, although no regular gradation can be observed: while Frémy holds that "The bone of a fœtus was found to yield the same quantity of ash as that of a woman of ninety-seven years of age." Although the actual number of analyses made by these

Total Quantitative Results.

	(1). The bark of the root.	(2). The wood of the root.	(3). The green part of leaf.	(4). The yellow base of leaf.
1. Moisture	6·78 per cent	11·67 per cent.	8·11 per cent.	37·00 per cent.
2. Total ash	17·38 ,,	15·75 ,,	5·75 ,,	10·63 ,,
3. Petroleum spirit extract	1·24 ,,	0·55 ,,	2·20 ,,	1·10 ,,
4. Ethereal extract	3·16 ,,	1·70 ,,	1·25 ,,	1·70 ,,
5. Alcoholic ,, ...	9·25 ,,	14·30 ,,	3·80 ,,	4·30 ,,
6. Aqueous ,, ...	4·03 ,,	16·10 ,,	4·35 ,,	11·35 ,,
7. Dilute soda ,, ...	1·09 ,,	2·41 ,,		
8. Wash residue	1·30 ,,			
9. Dilute acid extract	5·65 ,,	0·30 ,,		
Total percentage	49·88 ,,	62·78 ,,	25·46 per cent.	66·08 per cent.
Total albumenoids estimated on powder.	4·75 ,,	4·74 ,,	9·62 ,,	
Quantitative saponin determination on powder by A and B.		A. 8·95 per cent. B. 10·40 ,,		

Number.	Sex.	Colour.	Nationality.	Occupation.	Died of.	Age, years.	Per cent of ash.	Remarks.
1.	Specimen lost.							
2.	Male.	White.	—	—	Phthisis.	65	67·05	
3.	,,	Negro.	—	—	,,	21	65·89	Had scrofula.
4.	,,	White.	Russian.	Sailor.	,,	23	67·28	,, syphilis.
5.	,,	,,	American.	Farmer.	—	33½	67·63	Amputation.
6.	Female.	,,	Irish.	Actress.	Peritonitis.	23	67 66	
7.	Male.	,,	—	—	Phthisis.	60	67·55	
8.	Female.	,,	Irish.	—	,,	24	68·29	
9.	Male.	,,	—	—	,,	57	67·73	
10.	,,	,,	—	—	,,	58	67·60	
11.	,,	,,	—	—	,,	57	68·82	
12.	Female.	Negro.	—	—	?	25	68·20	Died of some bowel disease.
13.	Male.	White.	Irish.	Labourer.	Killed.	21	67·73	
14.	,,	,,	English.	Brewer.	—	31	66·51	Amputation.
15.	,,	,,	Irish.	—	—	8	64·86	Amputation.
16.	Female.	,,	,,	Domestic.	Phthisis.	46	69·67	Married.
17.	,,	,,	French.	—	Peritonitis.	57	67·60	,,
18.	Male.	,,	American.	Farmer.	Old Age.	81	68·56	
19.	,,	,,	Irish.	—	Apoplexy.	60	69·33	Married.
20.	,,	,,	,,	Labourer.	Bronchitis.	74	68·72	
21.	Female.	,,	American.	—	Phthisis.	44	68·30	Married.
22.	,,	,,	Irish.	—	,,	60	67·93	Insane.
23.	Male.	,,	German.	—	?	40	69·28	
24.	,,	,,	,,	—	?	53	68·23	
25.	,,	,,	Irish.	—	Phthisis.	56	68·94	
26.	,,	,,	,,	—	Brights'.	41	68·15	
27.	,,	,,	,,	Labourer.	Dysentery.	48	69·73	
28.	Female.	,,	American.	—	Phthisis.	29	69·18	
29.	,,	,,	,,	—	,,	34	69·82	
30.	Male.	,,	Italian.	Labourer.	Tetanus.	29	68·47	Died from wounds.
31.	Female.	,,	American.	Domestic.	Typhus fever.	24	67·99	
32.	Male.	,,	—	—	Nephritis.	49	69·35	
33.	,,	,,	—	—	Alcoholism.	58	68·69	
34.	,,	,,	Irish.	—	—	11	65·87	Amputation.
35.	,,	,,	German.	—	Phthisis.	59	68·93	
36.	Female.	,,	Irish.	—	,,	29	69·03	
37.	Male.	,,	,,	—	Pneumonia.	55	69·72	
38.	,,	Negro.	—	—	Phthisis.	45	69·06	
39.	,,	White.	German.	Brewer.	?	40	69·31	
40.	,,	,,	English.	Tailor.	?	73	69·85	
41.	,,	,,	Irish.	Labourer.	Killed.	38	69·05	
42.	,,	,,	,,	None.	Phthisis.	25	69·36	Drunkard.
43.	,,	,,	American.	Ostler.	Alcoholism.	63	68·07	,,
44.	,,	,,	English.	Coachman.	,,	43	65·11	Had syphilis.
45.	,,	,,	—	Shoemaker.	,,	45	65·16	
46.	,,	,,	—	Lawyer.	Old age.	70	62·82	
47.	Female.	,,	—	Prostitute.	Phthisis.	26	65·23	
48.	,,	,,	—	Domestic.	,,	31	65·61	Bone very brittle.
49.	Male.	,,	German.	Shoemaker.	,,	38	63·98	
50.	,,	,,	Irish.	Labourer.	?	61	63·54	

investigators was large, yet simple inspection of their tables will show that very few were made of the *same bone* in each case, and it is evident that a comparison between a femur, on the one hand, and a tibia on the other, could not be trustworthy.

It occurred to me as worth while to supplement their list, and I here present what may be considered a report of progress, very much yet remaining to be done.

The *extreme* difficulty of getting supplied with material, the history of which is certain and satisfactory, renders the work exceedingly slow.

The bone for examination was, in every instance, cut from the dense portion of the middle of the shaft of the femur. No subject was taken who had suffered from rickets or other serious bone disease, and women of recent confinement were also excluded. All specimens were obtained either from living persons (amputations), or those recently dead. After crushing with a steel mortar, extracting with ether, and again crushing, the ash was determined by incineration in a platinum dish. The results are in the appended table.

I think enough has been done to show that the common belief in the increased brittleness of bone with advancing years being due to increased percentage of inorganic salts is without foundation. The table indicates that after manhood is reached no variation in quantity of ash takes place as the years roll on.

"The greater brittleness of the bones in age is attributed by Frémy to the increase in the proportion of the spongy tissue, the thickness of the hard and dense portion of the bones continually diminishing as age advances." This has not been my experience. Transverse sections of the entire bone were made in each case in order to test this point, by observing the relative size of dense and spongy portions, and I certainly saw nothing to warrant such a conclusion. At the same time, small columns $\frac{1}{8} \times \frac{1}{8} \times \frac{3}{4}$ inch were cut from the dense portion of the shaft, and were broken transversely on a testing machine, in order to determine the amount of brittleness.

The most brittle specimen I had (No. 48) showed a rather thicker dense portion than usual.

I find the brittleness to be in the *material* rather than in the bone as a structure.

I append a very imperfect table of the results obtained on the testing machine. Every bone, as I received it, could not be cut so as to give a column of the size re-

quired for breaking. It will be noticed that, in general, strength of bone diminishes as age advances.

Loss of material by the burning of the laboratory affected, in a measure, the completeness of the work.

Breaking Weight for Column of Bone $\frac{1}{8} \times \frac{1}{8} \times \frac{3}{4}$ inch, Broken Transversely.

Age.	Pounds.
25 years.	75
26 ,,	74
31 ,,	50
38 ,,	64
43 ,,	58
45 ,,	60
61 ,,	55
63 ,,	30
70 ,,	54

Rensselaer Polytechnic Institute,
Troy, N.Y., July 28, 1887.

NOTICES OF BOOKS.

Notes on the Literature of Explosives. By Ch. Munroe. 1887. No. XIII.

In an abstract of a valuable paper by Prof. F. v. Rzika, upon "The Mechanical Efficiency of Explosives," we read that, according to various authors, 1 kilo. of gunpowder developes when exploded a theoretical power varying from 67,410 k.m. (Bunsen and Schischkoff) to 161,500 k.m. (Berthelot); but these results are exceeded by those obtained by MM. Roux and Sarran, who found that different powders of given constitution gave results varying between 242,335 k.m. and 343,102 k.m. Guncotton gave 448,927 k.m., and dynamite containing 75 per cent of nitroglycerin gave 548,250 k.m.

Experience has shown that, in blasting rocks, two to three times as much powder as dynamite will be required to achieve the same result, the theoretical relation being 1 : 2·26, which is a very close approximation when we consider the constantly changing conditions of rock-blasting.

The theoretical efficiency of an explosive cannot, however, be realised in useful work, because of incomplete combustion, the compression and chemical changes in the surrounding material, the cracking and heating of rock not moved, and because of the escape of considerable quantities of the gases through the blast-hole and the fissures formed by the explosion. The problem can therefore only be solved by means of analogy, such as firing shot from ordnance, &c. The mean of a large number of experiments gives the useful work from 1 kilo. of powder, when fired in a gun, as 43,788 k.m.; and taking MM. Roux and Sarran's value of the theoretical power latent in the powder as 319,982 k.m., we find that, under the average conditions of modern gunnery, we can only get a return of 13·71 per cent of the possible power.

In *Engineering News* a new explosive is partially described: it is the invention of M. Gruson. Although tried by the German Government so long ago as 1882, its composition is still kept partially secret. One ingredient is strong nitric acid, and the other a brown crystalline substance, non-explosive by itself, but burning like sealing-wax, often transported in commerce, insoluble in water, poisonous if eaten, but unknown in this special character of forming an explosive when dissolved in nitric acid.

Another new explosive is called "Bellite." It is more powerful than any other at present used.

Another remarkable one, invented by a Russian engineer, and called "Silotvaar," is said to possess ten times the power of ordinary powder, while at the same time "its explosion produces neither fumes nor smoke, and is not attended with any detonation." We only want to hear that it gives no recoil, and we shall be inclined to believe that the so-called explosive does not explode at all.

Journal of the College of Science, Imperial University, Japan. Published by the University, Tokyo. 1887.

The third part of this interesting Journal, which has recently appeared, gives ample evidence of the activity of scientific workers in that strange land which is making such rapid advances in European civilisation.

Messrs. Mitsukuri and Tshikawa contribute an important paper "On the Formation of Germinal Layers in Chelonia." The results of their observations and investigations most completely bear out the views taken by Balfour and Hertwig, viz., that the development of Amphioxus and Amphibia, on the one hand, and Reptilia on the other, is as complete as could be desired, and the authors express the hope that their investigations may furnish an intermediate step in firmly establishing the views of these two observers in higher Vertebrates.

Another paper which attracts attention is one on "The Severe Japan Earthquake of 15th January, 1887." Since 1879 there have been seven destructive earthquakes in Japan, but the shock of last January was of most unusual violence. It originated near the coast at a point about 35 miles from Tokyo, and the seismic waves travelled nearly 200 miles along the Pacific seaboard; they shook in all about 32,000 square miles of land. From observations recorded it is found that the greatest horizontal movement was 21 m.m., and the time taken to complete one to and fro movement was 2·5 seconds. The principal motion continued for more than two minutes, during which time no less than sixty distinct shocks occurred. The most probable cause of the shock was faulting or dislocation of the earth's crust, this inference being supported by the fact that the parts of the country through which the western half of the line of shock travelled consists of rocks of different geological formations, interwoven in such a way that their junctions present lines of weakness favourable to earth-snaps.

The damage to dwelling-houses was very great and widespread, but owing to their light construction (they are principally built of wood and bamboo) very few were entirely overthrown. The real destroyer, which is so much feared in connection with earthquakes in Japan, is fire. The extensive and rapidly increasing use of kerosine lamps in Japan augments the danger very considerably. In the great earthquake of 1855 fire broke out in more than thirty places in Yedo, and a large part of the city was quickly in a blaze. Fortunately this last shock only caused a few fires, and these were promptly extinguished.

*Handbook of Chemical Technology.** Edited by Dr. Bolley, and continued after his death by Dr. Birnbaum. First Volume, Third Group: *Chemical Technology of Fuel.* By Dr. Ferdinand Fischer. Braunschweig: Vieweg and Son.

This book, as it reaches us, is a "new thing under the sun." It begins on p. 161, in the middle of a sentence, without the luxuries of a preface, a table of contents, or even of a title-page beyond what we find printed upon the wrapper.

It opens with a fragment of the instructions for determining the heating power, apparently of coal. The author then proceeds to the examination of atmospheric air, giving elaborate instructions for the determination of moisture, of oxygen, carbonic acid, and carbon monoxide. Hydrogen sulphide, sulphurous acid, sulphuric and hydrochloric acid, and ammonia are much more briefly dispatched. Dust, or rather suspended matters, inorganic, organic, and organised, are also slightly noticed. It is

* Handbuch der Chemischen Technologie. Ersten Bandes, dritte Gruppe: Die Chemische Technologie der Brennstoffe.

maintained that the air of cesspools is especially rich in bacteria.

The next subject taken up is the examination of furnace and chimney gases, which is treated at great length and with the aid of a profusion of diagrams.

Next comes coal-gas, in which he determines specific gravity, carbon dioxide, ammonia, and sulphur.

In a following section the author returns to atmospheric air, giving additional means for the determination of oxygen, carbon dioxide, and monoxide. For the detection of small proportions of the latter it is proposed to shake up a sample of the suspected air with a solution of blood, previously mixed with ammonium sulphide, and in which the reduction-band has been first observed. Carbon monoxide-hæmoglobin is formed, and its characteristic band may be recognised spectroscopically. If a solution of blood, which, after treatment with ammonium sulphide and potassa lye, shows merely the characteristic absorption of hæmochromogen, is shaken up with air containing mere traces of carbon monoxide, there appears after standing a less intense absorption of hæmochromogen, and more or less strong bands of carbon monoxide-hæmoglobine. In this manner 0·033 per cent of this dangerous gas may be detected.

The remainder of the book is chiefly devoted to photometry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., Nos. 10 and 11, September 5 and 12, 1887.

These numbers contains no chemical matter.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 10, May 20, 1887.

Causes which determine the Phosphorescence of Calcium Sulphide.—A. Verneuil.—Already noticed.

On Alums.—E. Maumené.—Already noticed.

A Reaction serving for the Colorimetric Determination of Phosphorus in Cast-Iron, Steel, &c.—F. Osmond. — On dissolving the phospho-arsenio-silico-molybdic acids or their alkaline salts in a hydrochloric solution of stannous chloride, there is produced a blue colouration, proportional in its intensity to the quantity of the molybdic derivative produced. Under the same conditions, the salt of tin being always in large excess, ammonium molybdate gives a colouration which passes through blue (if the molybdate is in sufficient quantity), but turns quickly to a reddish yellow. The molybdic acid is finally converted into MoO_2. Upon the production of the blue colour just mentioned the author founds his colorimetric process for the determination of phosphorus in iron. He forms his stannous solution by dissolving 12 grms. of tin crystals in 80 c.c. of pure hydrochloric acid and making up to 1 litre with distilled water. The precipitate of ammonium phospho-molybdate obtained in the ordinary manner is filtered through asbestos (*not* paper), and after washing it is dissolved on the filter with a sufficient quantity of the stannous liquid. The filtered solution is then made up with the same liquid to 100 c.c. per grm. of the iron taken. It is then merely necessary to ascertain its colouring power.

Artificial Production of Magnetite.—Alex. Gorgen. —Already noticed.

A New Reagent for the Salts of Copper.—M. Aliamet.—The author dissolves neutral sodium sulphite, so as to have a solution saturated in the cold. He then adds pyrogallic acid, which dissolves very easily. This reagent is colourless, but with solutions of a copper salt of medium strength it gives an intense blood-red colour.

On the Hydrates of Sodium Arseniate. — H. Lescœur.—Already noticed.

A Combination of Hæmatine with Nitrogen Dioxide.—G. Linossier.—Already noticed.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1455.

THE RELATION OF SCIENCE TO THE STATE.

IV.

One evidence of the unsatisfactory state of Science in Britain is so simple and so convincing that it may save us the trouble of invoking any of the numerous and eminent authorities whose conclusions here coincide with our own, such as Professors Huxley, Frankland, Tait, Cook, Dr. L. Wiese, Sedley Taylor, and others. It is this:—At the end of scientific treatises of a monographic character we generally find a very useful appendix in the shape of the bibliography of the subject,—a list of the works, memoirs, papers, &c., in which it has been previously discussed. Now in such bibliographies the names of British investigators figure but to a very small extent. As an instance we may take a work on the animal alkaloids,—the ptomaines and leucomaines,—and, looking over the index, note how small a part has been played by British men of Science.

But we have now to search for the causes of our national inferiority. It cannot be explained by any inherent shortcoming of the British and Irish mind. The country which has produced Newton, Davy, Dalton, Young, Faraday, Darwin, not to speak of any one still living, may safely measure itself with any of its rivals. Prof. Max Müller declared, not very long time ago, that he intellects of British youth were "of the same calibre" as those of the Germans. If we have failed in doing what our interests and our honour demand, it is not from racial inferiority, not in virtue of any natural defects, but by reason of blunders which may yet be remedied if we can only be brought to see them in their true light.

The first great obstacle has been that spirit which finds vent in the miserable cuckoo-cry "*cui bono?*" This is not because we are more practical or more utilitarian than our neighbours. France, Germany, Belgium are all as greedy as we can be for the crumbs that fall from the table of Science; but they have confined themselves less closely to the demand for *immediate* results. They have had the insight or the faith to see the connection between the frog's leg, quivering on Galvani's work-table, and the electric light, the telegraph, and the telephone, and to judge that other abstract researches may be similarly fruitful. We have been less ready so to do, and here, if anywhere, lies our national inferiority. We alternate between vain-glorious self-confidence and fits of panic, in which we generally do the wrong thing. We seek to win the race by a succession of spurts, whilst our rivals press on "unhasting, unresting," taking their measures deliberately, and having an eye to the future as well as to the present.

Just now we are in one of our panic fits as regards scientific and technical training, and shall doubtless commit some piece of expensive folly.

Unfortunately the old utilitarian "*cui bono*" men have lately been reinforced by the ethicists who sneer, *e.g.*, at researches on the rare earths, asking "Could we not be as good and as happy if these rare earths had never existed?" But what we should be in the absence of what exists in creation is an utterly idle question, since possibly we ourselves should not be at all. To us the sense for truth is a craving which is its own justification.

However this may be, it must be admitted that the *cui bono* spirit is really the main origin of the unsatisfactory position of Science in our midst, other causes being but secondary. To these, however, we must proceed.

We shall do well to bear in mind—what some persons are inclined to forget—that scientific men, and those who might under favourable circumstances become such, have very much the same wants and the same feelings as other men. Hence if they find that a life devoted to original research—which is in itself an expensive pursuit—leads to semi-starvation, not compensated by public recognition or honours, they can scarcely be blamed if they decline to sacrifice themselves for the good of posterity, to whom, perhaps, their very names will never be known.

Hence in Britain scientific research has been confined mainly to those who combine with the necessary intellectual and moral gifts a position independent in a pecuniary point of view, and who are, further, careless of amassing wealth and indifferent to the honours which may be gathered in other pursuits. As Mr. Sorby has most convincingly shown, research, to be fully successful, needs unlimited leisure,—the opportunity to take up and study phenomena when they present themselves, and to follow out suggestions as they occur to the mind.

We must admit that a modern author pronounces "work supported by private means amateur work or duplicate work." This we hold to be a capital mistake, which is at once scattered to the winds if we mention the names of Cavendish, Lyell, and Darwin.

Meantime that Science, in the true sense of the word, "does not pay" is fully recognised by the world. If a young man shows an inclination for research he is duly cautioned not to be guilty of such folly. His friends advise him rather to turn his attention to the law, to politics, to divinity, or to speculation, the investigation of Nature being at best reserved as a pastime for leisure hours. Or he may be recommended to sink into the routine application of well-known truths, as an engineer or a physician. We are fully aware that engineers, physicians, lawyers, and clergymen have often made valuable contributions to the various sciences. But how much more could they have done had their whole time been at their disposal! We are told, with the fullest truth, that there is no commercial career open to a biologist. Mr. Proctor even tells us, in "Wages and Wants of Science Workers," that "the existence of a commercial career for the chemist has the effect of starving all the other sciences for the benefit of one of them." We are quite unable to accept this view. We do not see that the demand for the services of chemists can in the least interfere with the position of astronomers or biologists.

There is, of course, an opening for a small number of astronomers in observations, and for a few biologists in museums and botanical gardens; but, as far at least as astronomers are concerned, Mr. Proctor tells us that a careful avoidance of originality is the quality most valued in subordinates. Such establishments must therefore be ill adapted for a man capable of extending the boundaries of knowledge.

We further find that if any Government Department stands in need of advice or information which only a chemist, a physicist, or a biologist can furnish, it generally expects such work to be undertaken gratuitously. If the *savant* consulted asks beforehand what remuneration he may expect the matter is dropped, and if he acts as if he would do in case of a firm or company he is told that there are no funds applicable to such a purpose. But, on the contrary, if any *legal* service is required, though the person employed may be the most briefless of barristers, he is sure of being paid handsomely; so different is the treatment accorded respectively to Law and to Science.

Chemical and Thermic Study of the Phenolsulphuric Acids.—J. Allain le Canu.—The author concludes that the introduction of an electro-negative element in place of hydrogen effects scarcely any change in the thermic value of the first basicity, whilst it increases in a striking and progressive manner the value of the second.—*Bull. de la Soc. Chim. de Paris.*

THE THERMAL RESULTS OF NEUTRALISATION, AND THEIR BEARING ON THE NATURE OF SOLUTION.*

By W. W. J. NICOL, M.A., D.Sc., F.R.S.E. F.I.C., Lecturer on Chemistry, Mason College, Birmingham.

WHEN a solution of a base in water (one equivalent in 200 or more molecules of water) is neutralised by the requisite quantity of a solution of an acid of the same strength, the thermal change observed is the algebraic sum of the plus and minus quantities contained in the following thermal statement,—

$$-MOH, Aq - M,OH - HR,Aq - H,R + M,R + MR,Aq + H,OH + H_2O,Aq,$$

where M and R are equivalents of metal and salt-radical respectively. With the single exception of $H_2O,Aq = O$ we have not the slightest knowledge of the value of any of the terms of the above statement; for it must be constantly remembered, in considering these questions, that MOH,Aq, HR,Aq, and MR,Aq are not the heats of solution of solid or even liquid base acid or salt, but are the thermal results of the bringing in contact of single molecules of these substances and a very large excess of water. Similarly M,OH, H,R, M,R, or H,OH is the thermal resulting from the formation of single independent molecules of these substances, not of solid or liquid aggregates of their molecules.

It has been found by experiment that the algebraic sum of the above thermal changes is a constant whatever may be the value of M (provided always that MOH is soluble in water), and that various values of R give definite constants for all values of M. That is—

$$-M,OH - MOH,Aq - H,R - HR,Aq + M,R + MR,Aq + H,OH + H_2O,Aq = = -M',OH - M'OH,Aq - H,R - HR,Aq + M',R + M'R,Aq + H,OH + H_2O,Aq.$$

Or simplified—

$$-M,OH - MOH,Aq + M,R + MR,Aq = = -M',OH - M'OH,Aq + M',R + M'R,Aq.$$

Which may be written—

$$M,R,Aq - M,OH,Aq = = M',R,Aq - M',OH,Aq.$$

Now, setting R' = OH, we have—

$$M,R,Aq - M,R',Aq = M',R,Aq - M',R',Aq,$$

and this equation is found to hold good for all values of M and M', R and R'.

Such an equation is valid under one or other of three conditions:—

1st. All the four terms are equal.
2nd. The first and third are equal, the second and fourth are equal.
3rd. None of the four terms are equal: there is thus equality only in the differences between each pair.

This last is the condition obtaining here, for if we set M = K, M' = Na, R = Cl, R' = Br, then—

$$K,Cl,Aq - K,Br,Aq = Na,Cl,Aq - Na,Br,Aq.$$
$$101{\cdot}170 - 90{\cdot}230 = 96{\cdot}510 - 85{\cdot}580.$$
i.e., 10·940 cals. = 10·930 cals.

Now each of the terms of the above equation consists of two parts. Thus M,R,Aq can be divided into M,R and MR,Aq, and so with the others. We are thus confronted with the question, Does the same relation of equality exist between the equations obtained by dissecting the original equation, or does it not? Do—

$$M,R - M,R' = M',R - M',R', \text{ and}$$
$$MR,Aq - MR',Aq = M'R,Aq - M'R',Aq,$$

or do they not?

* Read before the Chemical Section of the British Association, Manchester Meeting.

If they do not,—if MR,Aq − MR',Aq do not equal M'R,Aq − M'R',Aq,—then it follows that there is no connection between the heat of solution (in the restricted sense defined above) and the chemical composition of the salt. But the heat of solution of single salt molecules must depend on their chemical composition, whether the act of solution be chemical or physical. It seems to me impossible that it could be otherwise. We must not be led away by the absence of such relations in the case of the heat of solution of solid salts, for in these cases the question is complicated by physical conditions, such as exigencies of crystalline form, rapidity of cooling, &c., and it is only in certain instances that we can trace out the connection.

A great deal of light may, however, be thrown on this point by the study of the vapour pressure of water from dilute salt solutions. The restraining effect of salt on the vapour pressure of water is in dilute solutions a direct measure of the attraction exerted by the salt molecule on the water. This is best expressed by the value of—

$$\frac{p - p'}{n\,p} \times 1000,$$

where p = pressure of pure water, p' = pressure of vapour from the salt solution at the same temperature, and n = number of salt molecules present per 100 H_2O. At present the data are very insufficient in number for the proper examination of this point; but if we examine the figures given by me for sodium chloride and nitrate, potassium chloride and nitrate, we shall find that they are satisfactorily confirmed by Emden (*Wied. Annal.*).

	NaCl,Aq.	−	$NaNO_3$,Aq.	=	KCl,Aq.	−	KNO_3,Aq.
Nicol ..	192	−	189	=	172	−	171
Emden..	208	−	208	=	178	−	181
Mean	200	−	199	=	175	−	176

In this case it would seem that the metal played the important part in determining the attraction, but I wish to insist more on the knowledge to be gained from such experiments than on the strict accuracy of the figures given above: the subject of vapour pressures is one that is beset with innumerable experimental difficulties, and has by no means received the attention it deserves.

Again, this equality of relationship between the heats of solution of different salts is highly probable, for the attraction, adhesion, chemical or physical, whatever it may be that exists—as it undoubtedly does—between the salt and the water, must be connected directly with the composition of the salt.

Turning now to the other equation,—

$$M,R - M,R' = M',R - M',R'.$$

This also must hold if the equation of the heat of solution holds good. There will thus be a constant relationship observable between the heats of formation of single molecules of the salts in question. We have unfortunately no means of ascertaining whether this is the case or not. Nor is there any indirect evidence which can throw any light on this: still a little reflection will show that it is in accordance with the probabilities of the case.

When a metal, M, is brought in contact with a salt radical, R, they unite to form a salt, MR, and the thermal change M,R is a function not only of M, but also of R. This two-sidedness of such reactions is too apt to be lost sight of in considering such combinations. The kinetic energy resulting from their union is dependent for its amount on the nature of both constituents of the salt. Now either the whole of the potential energy of M and of R is converted into kinetic on their union, or only a portion of it, and the same is true of M,R'. If the whole of the potential energy is converted, then any difference in the total kinetic energy must be due solely to the difference in the potential energy of R and R'. Similarly with M',R and M',R' it is evident that the difference can be due only to R and R', that is—

$$M,R - M,R' = M'R - M',R'.$$

If, on the other hand, only a portion of the potential energy of M and R be converted, two conditions are possible :—

1st. One or other of the constituents has the whole converted, the other not.

2nd. Neither constituent has the whole converted.

In the first case, if M has the whole converted, then the difference must be due to the difference between R and R′; or, if R, then to the difference between M and M′ and the equation still holds good.

In the second case, where only a portion of the potential energy possessed by constituents is converted into kinetic energy, it seems to me that the only possible state of things is as follows :—

The amount of energy converted in the case of M must be dependent on the nature of R and of R′ respectively, and in the case of R and R′ on the nature of M. This must also be the case with M′, and consequently, though the total kinetic energy in the various cases may be exceedingly different in amount, there is still an equality in the differences as in the other cases. Were it otherwise, then the amount of potential converted into kinetic energy would not be conditioned by the chemical nature of the various constituents, but be due to some other property as to the nature of which it is useless to speculate.

The whole of the foregoing may be summarised thus if the thermal change is in any way dependent on the chemical nature of the constituents; then $M,R - M,R'$ must equal $M',R - M',R'$.

That there is no relationship of this kind exhibited by the heat of formation of the solid salt is only what is to be expected, as I have already pointed out in the case of heat of solution. It is the simplicity of constitution in solution that reveals these relations,—a simplicity compared by Thomsen to that of the gaseous state.

The enormous dilution necessary before the exact equality is observable, in many cases, is also strongly in favour of this view, for all our experimental evidence points to this, that the more dilute the solution the more perfect the equality. Now such a variation of the thermal results with the amount of water present, if the whole is to be ascribed to chemical causes, would point to a chemical action varying continuously with the amount of water. Such an action cannot be a dissociative one, for the vapour pressures show that the whole of the water is affected by the salt, and in the majority of cases there is no room for believing in the dissociation of the salt itself. We are therefore driven to the conclusion that the action, if chemical, is due to the chemical combination of the salt with the water, and consequently to admitting the existence of chemical compounds absolutely indefinite in composition, this being conditioned solely by the amount of water present.

For the discussion of these questions from a totally different standpoint, reference may be made to a paper by Pickering (*Chem. Soc. Journ.*, 1887), where diametrically opposite conclusions are arrived at.

ON THE

ESTIMATION OF POTASH IN COMMERCIAL FERTILISERS.

By DAVID LINDO.

The following is an outline of a method proposed by Gladding at the Second Annual Meeting of Official Agricultural Chemists at Washington, September, 1885, for separating and estimating potash in superphosphates.

Boil 10 grms. of the fertiliser with 300 c.c. water for ten minutes; precipitate the solution when cold with ammonia in slight excess; make up the volume to 500 c.c., mix thoroughly, and filter through a dry filter.

Take 50 c.c. of the filtrate, corresponding to 1 grm. of the manure; evaporate nearly to dryness, add 1 c.c. dilute H_2SO_4 (1 to 1), evaporate to dryness, and ignite the residue until perfectly white. Dissolve the residue in hot water plus a few drops HCl, and 5 c.c. of a solution of pure NaCl (containing 20 grms. to the litre) and an excess of platinum solution, the whole to be evaporated as usual. The precipitate is to be washed thoroughly, first with alcohol, then with a half saturated solution of NH_4Cl, (which has been saturated with K_2PtCl_6), finally again with alcohol; dried and weighed as usual.*

The presence of the residue and precipitate in the measuring flask will, of course, give rise to a slight error in excess, which may be balanced or more than equalised by the precipitate carrying down a little of the potash salt. Experiments were tried—

1st. To ascertain if the method will give concordant results.

2nd. To ascertain if the results obtained by it are fairly accurate.

Experiments to Ascertain if the Method will give Concordant Results.

These were made with a so-called black guano, which was sent to me as a well mixed sample. It was in the state of a tolerably fine black powder, free from lumps.

I transferred it at once to an accurately ground reagent bottle, in which it was kept during the estimation of the following constituents, and during the potash estimates which were made after.

Each time, before taking out a portion for analysis, the bottle was well shaken.

Moisture expelled at 100°	14·58	per cent.
Ammonia (by distillation)	5·55	,,
Phosphoric acid, P_2O_5, total	11·83	,,
Phosphoric acid, P_2O_5, soluble in cold water	8·24	,,
Lime	16·08	,,
Magnesia	0·42	,,
Sulphuric acid, SO_3	28·36	,,
Chlorine	4·01	,,
Silica	0·50	,,
Ferric oxide	0·21	,,

Alumina was absent, and only a trace of soda present, a little animal matter was also present, and a rather considerable quantity of carbon.

Before giving the results of the potash estimates, I may state.

1st. That 50 c.c. of 6·34 per cent ammonia were added to each solution from 10 grms. of manure. This is more than a slight excess, but it was found, when slight excess —judging by the action on pink litmus-paper—was used, phosphoric acid and lime were sometimes *both* present in the filtrate, in which ammonia produced a further precipitate. Phosphoric acid will, as a rule, be present whether slight or large excess of ammonia is employed, if the fluid is filtered from the residue, soon after precipitating with ammonia. Its presence does no harm, at least in the absence of an appreciable quantity of lime.†

2nd. The 50 c.c. of filtrate taken for each estimate were evaporated, and the residue was ignited in a platinum dish.‡ The dissolved residue was transferred to a porcelain basin, and the NaCl and platinum solutions added.

3rd. The evaporation was always carried to dryness, as I believe this to be the safest plan.

4th. The K_2PtCl_6 in these experiments was always obtained in minute crystals, rendering crushing unnecessary, but the mass was worked with a trimmed feather with a little alcohol in the dish three or four times before transferring to the Gooch crucible, in which the washing was completed.

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* See Chemical News, vol. liii., p. 202, for further details.

† Less ammonia, however, than I have used in these experiments, would ensure complete precipitation of the lime, and, in practice, less should be used, unless alumina is known to be absent, as it was in all these experiments.

‡ When chlorides and nitrates are both present the evaporation with sulphuric acid must not be carried on in a platinum dish.

5th. The K_2PtCl_6 was dried at 130° C., and the factor 0·3056 used to convert into KCl. Repeated experiments have shown that when the salt is dried to constant weight at this temperature it always contained 30·56 per cent KCl.

6th. The platinum solution contained 1 grm. of metal in 20 c.c., and 8 c.c. were used in each estimate.

Five boils were made, using 10 grms. of manure for each, and two or three estimates were made from each filtrate; the results are given below.

TABLE I.

No.	Weights of precipitates in grms.	= KCl.	Per cent in manure.	Average.
		Solution A.		
1.	0·2371	0·072457	7·25	7·24
2.	0·2367	0·072330	7·23	
		Solution B.		
1.	0·2374	0·072549	7·25	7·25
2.	0·2375	0·072580	7·26	
3.	0·2371	0·072457	7·25	
		Solution C.		
1.	0·2305	0·07044	7·04	7 05
2.	0·2309	0·07056	7·06	
		Solution D.		
1.	0·2329	0·07117	7·12	7·12
2.	0·2329	0·07117	7·12	
		Solution E.		
1.	0·2326	0·07108	7·11	7·11
2.	0·2331	0·07123	7·12	
3.	0·2324	0·07102	7·10	

From these results we may infer that when several estimates are made from the same filtrate, using equal volumes, the results will be concordant.

That the various solutions have yielded a variable proportion of potash may be due to one or more of the following causes:—

1st. Imperfect mixing, the potash salt not being evenly diffused through the manure.

2nd. The few minutes boiling not having sufficed, in some instances at least, to extract all the soluble potash salts.

3rd. To the precipitates caused by ammonia carrying down a *variable* quantity of potash salt.

The balance of the manure was passed twice through an 18 mesh sieve, and very carefully mixed after each sifting. It absorbed sufficient moisture from the atmosphere under this free exposure to lower the tenor of all other constituents sensibly; therefore, the potash would come out lower without a correction, which, however, the experiments being merely to test concordance of results, it was quite unnecessary to make.

Six solutions were prepared, using 10 grms. for each, and one estimate made from each filtrate. The results are given in Table II.

TABLE II.

Weights of precipitates in grms.	= KCl.	Per cent in manure.
	Solution A.	
50 c.c. gave 0·2279	0·069646	6·96
	Solution B.	
50 c.c. gave 0·2299	0·070257	7·03
	Solution C.	
50 c.c. gave 0·2289	0·069951	7·00
	Solution D.	
50 c.c. gave 0·2291	0·070012	7·00
	Solution E.	
50 c.c. gave 0·2280	0·069676	6·97
	Solution F.	
50 c.c. gave 0·2286	0·069860	6·99

In preparing A and B the manure was boiled with the water fifteen minutes. C was not boiled but digested at ordinary temperature (30° C.) for about three hours, with frequent stirring. D, the manure, was stirred well with the 300 c.c. water, and the ammonia added at once.* E and F boiled in each case for two hours, renewing the water occasionally.

That the results are not quite as regular as those obtained when two or three estimates were made from the same filtrate (Table I.) may be due to the precipitates caused by ammonia carrying down a variable quantity of potash salts. We may conclude, however, that with a well mixed sample the method will give results at least fairly concordant.

Experiments to Ascertain if the Results obtained by the Method are Fairly Accurate.

Two artificial manures were prepared, one black and the other white.

Black Manure.—Bone-ash 100 grms.; animal charcoal (giving 15·04 per cent ash) 40 grms.; washed and dried; added 45 c.c. commercial pure sulphuric acid and 45 c.c. water in small quantities at a time alternately. After mixing, dried on water-bath, and ground fine. Added 40 grms. ammonic sulphate and 10 grms. magnesic sulphate (crystals), dried again, passed twice through 18 mesh sieve, mixed well, and left the mass lightly covered, stirring occasionally, until sufficient moisture had been absorbed, to admit of accurate weighing.

The phosphoric acid, lime, and ammonia were estimated.

Phosphoric acid, P_2O_5, total	14·20
,, soluble P_2O_5, 13·36 p.c.	
Lime	19·28
Ammonia by distillation	3·53

A preliminary experiment having shown it would be difficult to burn the residue white, in trying blank experiments with this manure, in consequence of alkaline salts being practically absent, 8 per cent of pure NaCl was added.

White Manure.—30 grms. microcosmic salt, 5 grms. magnesic sulphate (crystals) and 22 c.c. pure (re-distilled) sulphuric acid, mixed in a mortar. Added gradually 30 grms. pure calcic carbonate (precipitated by ammonic carbonate), dried, ground, sifted, and treated as above, to ensure accurate weighing.

The phosphoric acid was estimated, and from the result the ammonia and soda have been calculated.

Phosphoric acid, P_2O_5, total	12 14
,, soluble P_2O_5, 12·05 p.c.	
Sodic hydrate (calculated)	6·84
Ammonia (,,)	2·90

Three blank experiments were made with each manure.

Method.—2 grms. manure boiled a few minutes with 50 c.c. water, when cold added 10 c.c. 6·34 per cent ammonia; made up to 100 c.c., filtered off 50 c.c., and proceeded exactly as if potash were present.

Black Manure.

	Weight of precipitates in grms.
Blank 1	0·0066
,, 2	0·0065
,, 3	0·0067
Average	0·0066

White Manure.

	Weight of precipitates in grms.
Blank 1	0·0010
,, 2	0·0010
,, 3	0·0005
Average	0·0008

* In practice I should always boil for a few minutes. It can do no harm, and it is just possible that with some samples cold water might not extract all the soluble potash salts.

The KCl used in the experiments that follow was prepared from purified potassic chlorate. I employed a 2 per cent solution, in preparing which the salt and water were both accurately weighed. Two of these solutions were made during the course of this enquiry; the results of their analysis by silver are given below.

No.	KCl taken.	Weight of precipitate. =	KCl found.
1.	0·205296	0·3946	0·20527
2.	0·198296	0·3812	0·19830

In practice not less than 10 grms. of a fertiliser—as recommended by Gladding—should be treated for a potash estimate, to ensure a fair average, but in these experiments much less could be used, the question of perfect mixing being excluded by adding a weighed quantity of KCl solution to the quantity of manure taken in each experiment.

Method.—The solution of KCl was roughly measured, transferred to a tared porcelain crucible, then accurately weighed, with the cover of the crucible on. Added 2 grms. of manure, and evaporated the whole to moderate dryness on a water-bath. The mass was then transferred to a beaker, boiled a few minutes with 50 c.c. water, 10 c.c. 6·34 per cent ammonia added, made up to 100 c.c., filtered off 50 c.c., and proceeded as usual.

In experiments 1, 2, and 3 with both manures 5 c.c. NaCl and 8 c.c. platinum solutions were used. In experiment 4 with both manures 8 c.c. NaCl and 16 c.c. platinum solutions were employed. The results are given in Table III.

Table III.

Black Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0066. =	KCl found.
No. 1.	0·020214	0·0652	0·01992
,, 2.	0·034672	0·1118	0·03416
,, 3.	0·074844	0·2409	0·07362
,, 4.	0·140386	0·4510	0·13782

White Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0008. =	KCl found.
No. 1.	0·022721	0·0734	0·02244
,, 2.	0·043158	0·1401	0·04281
,, 3.	0·072614	0·2348	0·07175
,, 4.	0·135326	0·4403	0·13455

The black manure, from its containing bone char, and giving a very voluminous precipitate with ammonia, is perhaps as unfavourable a sample as could have been selected to test the method with, while the white manure is probably just the reverse.

There can be little doubt the method will always give results somewhat below the truth, though, for the purpose intended, it may be considered sufficiently accurate.

The error with manures containing less than 8 per cent potash is not likely, in careful hands, to be much over 0·1 per cent, and will often be less. To ascertain if it occurs in the first stage of the process, which terminates in a filtrate, 50 c.c. of which, it is assumed, contains all the soluble potash salts in 1 grm. of manure; or in the second stage, in which the potash is separated from this filtrate, or partly in both, the following experiments were made.

In each experiment 2 grms. of manure were treated exactly as as in the blank experiments. When the 50 c.c. of filtrate had been transferred to the platinum dish, a weighed quantity of KCl solution was added, and the analysis proceeded with as usual. The results are given in Table IV.

It is pretty evident the result of experiment No. 3, with the black manure, is accidental, and that the loss which occurs takes place during the first stage of the process. I may conclude by observing that the difficulty in arriving in perfectly concordant and accurate results in estimating the various constituents in these manures is often considerable, owing to their hygroscopic instability, and the great trouble which getting a perfectly uniform mixture entails. But quite apart from this, the accurate separation of a small quantity of potash from such a mixture is a problem presenting difficulties which it is not too much to say our present analytical methods are insufficient entirely to overcome. The method proposed by Mr. Gladding is simple and expeditious, in these respects much superior to the standard method, which, if we are to judge by the published figures, does not often give as accurate results, even in the hands of experienced analysts, as the former method, to judge by the results here recorded, is certainly capable of affording.

Falmouth, Jamaica, B.W.I.,
August 15, 1887.

Table IV.

Black Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0066. =	KCl found.
No. 1.	0·052146	0·1714	0·05238
,, 2.	0·065898	0·2156	0·06589
,, 3.	0·042872	0·1379	0·04214

White Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0008. =	KCl found.
No. 1.	0·055726	0·1826	0·05580
,, 2.	0·066606	0·2180	0·06662
,, 3.	0·046552	0·1526	0·04663

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 156).

3. *The Components of Thulium.*

In 1879 Cleve gave the name of thulia to the stronges base of all the erbia earths which give absorption-spectra In consequence of its basicity this oxide, even after several hundred careful decompositions of the mixed nitrates, remains in solution as a nitrate and becomes concentrated along with ytterbia in the mother-liquors. It has not been hitherto found practicable to obtain thulium free from ytterbium. Thalén, however, succeeded in establishing the spark-spectrum of thulium, having eliminated the ytterbium lines. Thulium oxide, if ignited in a flame, gives without volatilisation a discontinuous spectrum with two bands at $\lambda=684{\cdot}0$ and $\lambda=476{\cdot}0$. Lastly, the thulium salts, according to Thalén, give in transmitted light two absorption-bands at $\lambda=684{\cdot}0$ and $\lambda=465{\cdot}0$. The former was found more intense than the line $\lambda=465{\cdot}0$. The authors give the intensities of the two thulium lines according to their observations.

In the cases 1, 2, 3, 6, 7, and 8 of this table $\lambda=684{\cdot}0$ was always rather more strongly visible than $\lambda=465{\cdot}0$, and where the former line was fainter the latter was scarcely perceptible, or not at all. The observation of these spectra does not suggest any doubts as to the elementary character of thulium. Such doubts, however, are raised on comparing the results of an examination of the Arendal euxenite with those obtained from the mother-liquors of the ytterbia earths.

Fractions VIII. to XIV. of the euxenite material do not show $\lambda=465{\cdot}0$ at all, whilst at the same time $\lambda=684$ appeared rather strong or strong. The latter line appeared equally strong in the mother-liquors series 41 to 46, and yet $\lambda=465{\cdot}0$ was observed here rather strong.

In the spectrum of the earthly nitrates from—	There were observed the relative intensities of the thulium lines for— λ=684·0.	λ=465·0.
1. Thorite of Brevig	Extremely faint.	—
2. Euxenite from Hitterö, Fractions I. to IX.	Faint.	—
3. Euxenite Fract. III., IV., and V.	Faint to rather strong.	—
4. from „ VIII.	Rather strong.	—
5. Arendal. „ IX. to XIV.	Strong.	—
6. Mother-liquors Series 41 to 46	Strong.	Rather strong.
7. from preparation of „ 47 to 53	Strong.	Faint.
8. Ytterbia-Earths. „ 54 to 60	Rather faint.	Extremely faint.
9. Fergusonite from Arendal, Fractions VIII. and IX.	Rather strong.	—!
10. Thorite from Arendal, Yttria Earths	Rather strong.	—!

The relative proportion of the absorptions in the two thulium bands is therefore, in both these cases, not equal, as would be the case if thulium were a unitary body, a chemical element. That it consists of at least two elements appears further from a comparison of the spectra of the mother-liquors 54 to 60 with those of the fractions VIII. and IX. of the Arendal fergusonite and the yttria fraction from the thorite of Arendal. In the mother-liquors λ = 465·0 can be plainly recognised, though λ=684·0 appears rather faint. The stronger must the latter line be visible in the spectra of the fergusonite or thorite material from Arendal, as in them λ=684·0 comes out not rather faint, but rather strong. The substance whose nitrate has the line λ=465·0 in its absorption-spectrum appears not to occur at all in fergusonite and in the thorite of Arendal.

The authors propo e the name Tmα for the element whose nitric solution gives in the spectrum the band λ=684·0 and Tmβ for that which produces λ=465·0 under the same circumstances.

4. *On the Components of Didymium.*

Two years ago Auer von Welsbach resolved didymium by fractionated crystallisation of the double ammonium nitrate in a strongly nitric solution into two constituents which he named praseodymium and neodymium. The absorption-spectra of the compounds of these elements are portions of the absorption spectrum hitherto regarded as characteristic of didymium. If these elements are mixed in certain proportions both the colour of the solution and the original spectrum of didymium re-appear unchanged.

Hereby, as well as by the researches of Cleve, it is proved beyond doubt that didymium is a compound body. Unfortunately it was not practicable for the authors to ascertain any details on the constituents of didymium from Auer's memoir, the results of which depend upon spectroscopic examinations of the different fractions.

Certainly, beautifully executed drawings of the several spectra are appended to the memoir, but as the position of the single lines is only given with reference to an arbitrary scale, and as auxiliary values for the reduction to wave-lengths are not supplied, these communications have almost an exclusive interest for their author.

From what follows it may be seen that didymium consists of more than two components. As the spectrum of didymium nitrate is made up of a rather great number of lines, the undertaking to infer the number of the component elements of didymium from the nature of its spectra in different minerals and fractions is laborious. To facilitate it we gave up, for the present, the attempt to establish the relation of several lines, which appeared but faint, or very faint, to other didymium lines. As for the relative intensity of the more strongly visible absorption-bands, it will be more convenient, on account of the great number of lines, if we express their relative intensity by numbers instead of words. Let 1 stand for very strong, 2 for strong, 3 for rather strong, 4 for rather faint, 5 for faint, and 6 for very faint.

If the intensities are always in the first place compared with one of the didymium lines in the different cases observed it will be seen that the relative intensities of almost all didymium lines in the different spectra are variable.

The intensities of λ=728·3 : λ=679·4 in the spectrum of euxenite (Hitterö), Fraction I., are as 2 : 2, but in the holmium material as 3 : 2 ; λ=728·3 and λ=679·4 cannot, therefore, belong to the same body ; the substance whose nitrate produces λ=679·4 does not occur at all in the holmium material. From an analogous comparison of the intensities of the other lines with those of λ=728·3 in the different cases it results that λ=728·3 does not belong to a unitary body in common with any of the other didymium lines, and that its presence in the spectrum always shows the presence of a peculiar element in the substance examined.

If we compare the intensities of the other bands with those of all the other didymium lines mentioned we must, after examining the above table, form the opinion that at most λ = 679·4 and λ = 512·2, λ = 579·2 and λ = 575·4 belong together. All the other didymium lines are due to the absorption of the nitrates of different elements, as the proportion of their intensities is very variable. It would lead us too far to discuss at length all the relative intensities of the individual lines; their changing relations appear sufficiently from the table below.

As for the lines λ=679·4, 512·2, 579·2, and 575·4, we see from the above that the proportion of the intensities of λ=579·2 and λ=575·4 is always the same ; λ=575·4 is always to be seen where λ=579·2 occurs, and the latter is always stronger than the former. We have, therefore,

In the spectra of—	The following didymium lines have the following relative intensities. λ =	728·3.	679·4.	579·2.	575·4.	521·5.	512·2.	482·0.	469·0.	445·1.	444·7.
Thorite of Brevig		3	5	4	5	6	5	6	4	1	1
Thorite of Arendal, K_2SO_4 precipitate		1	5	1	1	2	5	2	2	2	2
Wœhlerite of Brevig		2	5	2	3	2	6	3	2	2	1
Cerite of Bastnäs		2	3	1	1	1	5	2	2	—	1
Samarium material		—	—	5	6	6	—	—	—	—	2
Praseodym material		2	6	2	3	3	5	4	3	—	1
Fergusonite of Arendal, Fraction I.		2	6	1	2	2	5	—	6	—	5
Fergusonite of Ytterby		3	6	1	2	2	5	—	6	—	5
Euxenite of Hitterö, Fraction I.		2	2	1	1	2	1	1	2	—	1
Holmium material		3	—	—	—	5	—	6	6	—	—
Euxenite of Arendal, Fraction I.		2	6	1	2	3	4	3	—	—	3

no reason to doubt that λ=579·2 and 575·4 are produced by the absorption of the nitrate of a unitary body.

As regards the possibility that λ=679·4 and 512·2 belong together, we refer to the first fractions of the fergusonite of Arendal; λ=679·4 increases in strength from Fraction I. to III., whilst λ=512·2 declines rapidly in intensity from Fraction I. to II. The oxides whose nitric solutions produce λ=679·4 and 512·2 behave, therefore, differently on the decomposition of their nitrates. Hence it does not appear possible to ascribe the lines λ=679·4 and λ=512·2 to one and the same element.

Ten years ago the "old" didymium was resolved into samarium and true didymium. From the above it appears that this didymium in all probability consists of not fewer than nine elements. At the same time it appears that Auer von Welsbach's neodymium and praseodymium are compound bodies. Further, it seems, according to the figures of the spectra of Auer's components of didymium, as if in his didymium material that body was present which we designate as Xη.

Accordingly we are compelled to drop the names neodymium and praseodymium, and to designate the components of didymium as—

Symbol.	Characteristic lines. λ=
Diα	728·3
Diβ	679·4
Diγ	579·2 and 575·4
Diδ	521·5
Diε	512·2
Diζ	482·0
Diη	469·0
Diθ	445·1
Diι	444·7

As for the mutual connection of the didymium lines λ=708·2, 626·1, 591·5, 531·3, 530·0, 514·6, it has not as yet been ascertained, as they came out almost always very faintly. The authors propose, therefore, to call these lines by the general name Di.

Finally, they point out that on examining a didymium material from the cerite of Bastnäs, as well as of Cleve's didymium, the existence of a body was recognised, which cannot be identified with any of the other constituents of didymium. To the nitrate solution of this element there belong the absorption-bands λ = 690·5, λ = 525·2, and λ=434·0. All these the authors designate as Di.

(To be continued).

NOTICES OF BOOKS.

Coal-Tar and Ammonia. Being the Second and Enlarged Edition of "A Treatise on the Distillation of Coal-Tar and Ammoniacal Liquor." By GEORGE LUNGE, Ph.D., Professor of Technical Chemistry in the Federal Polytechnic School, Zürich. London: Gurney and Jackson (Successors to Mr. Van Voorst).

THAT a second edition of Dr. Lunge's work should have become necessary is far from surprising; but we have here no mere reprint of the treatise in its original form. The enlargement mentioned on the title-page is a substantial reality. The letterpress has grown from 383 to 739 pages, and the number of diagrams has increased from 88 to 191. Even where no enlargement has taken place a very considerable portion of the book has been re-written. In fact, on comparing the two editions, we find the author fully justified in saying that there are but few pages in this new edition which have been taken unchanged from the former one.

Among the most important additions are the sections on the tar and ammonia obtained from coke burning, from blast-furnace gases, &c. Research and experiment in this direction have been lately much discouraged by the extremely low price of coal-tar and its products; but the increasing demand, of which our author makes due mention, will doubtless cause these attempts to be resumed. It is highly desirable that the manufacturer of coal-tar products may have at his disposal the greatest possible number of sources of his raw material. It is further very important that the by-products of the coke manufacture should be arrested and utilised instead o —as was formerly the case—escaping into the air and creating a nuisance. These objects have to a great extent been realised by the improved coke-ovens, those especially of the Simon-Carvès system. The utilisation of the volatile products has been greatly retarded on the Continent, and still more in England, by the belief that coke manufactured in other than the old bee-hive ovens was unfit for metallurgical uses,—a prejudice which has only gradually been overcome.

The tars, too, obtained in the earlier attempts at recovery, were of a very poor quality, and could scarcely pay for the expense of collection. A sample made at the Bear Park coke-works with Simon-Carvès ovens is of a fairly useful quality, and approximates not remotely to retort tars. According to the results here quoted from the *Journal of the Iron and Steel Institute*, the authority being Mr. Watson Smith, 1 ton of tar yielded 1·44 gals. of a 50 per cent benzol and 48·2 lbs. of a 28 per cent anthracene.

Dr. Lunge discusses the bold proposal thrown out by the late Mr. Weldon and others, that alkali-makers and other manufacturers in the coal districts, instead of feeding the raw coal into their furnaces, should convert it into coke, using the latter, *plus* the gas evolved, as fuel, whilst the tar and ammonia were to pay for the small coal consumed, so that they would get their fuel for nothing. Dr. Lunge pronounces this a splendid conception, but considers its practicability more than doubtful. So eminent an authority as I. Levinstein, indeed, holds that Weldon's proposal might succeed where the weekly consumption of coal does not fall below 300 tons, and if the coal gas is deprived of its benzol by the action of a fatty absorbent; but the author contends that such absorption processes are still on their trial. M. Scheurer-Kestner calculates the loss of heat-producing power in converting coal into coke and gas at 19·3 per cent.

Many varieties of coal-tars and natural tars, as it is here pointed out, are rendered worthless for the colour-maker by the presence of paraffin and kindred substances of the fatty series. An industrial method of separating these paraffinoids from the benzenoids is a desideratum.

We can only give a passing glance at the improvements —actual or prospective—in the manufacture of ammonia. It is here stated that if the furnace-gases of Scotland alone could be treated for the recovery of ammonia, an annual yield of 18,000 tons of ammonium sulphate would be secured. In the sewage of London there is wasted yearly, in the form of urine, ammonia capable of yielding 60,000 tons of sulphate. But the process which shall recover this valuable matter on commercial terms has yet to be discovered. None of the many methods proposed for obtaining ammonia, or indeed cyanogen or nitric acid, from the nitrogen of the atmosphere, has as yet gone beyond the experimental stage.

The first edition of this book was, we believe, without a rival in its own department; that now before us is of very much greater value, and will sufficiently recommend itself to all competent judges.

A New Dictionary of Chemistry, illustrated with Figures inserted in the Text, comprising its Applications to the Sciences, the Arts, to Agriculture, and to Industry. ("Nouveau Dictionaire de Chimie, illustré de Figures intercalées dans le Texte, comprenant les Applications aux Sciences, aux Arts, a l'Agriculture, et a l'Industrie.") By EMILE BOUANT. Part I. A—Chaleur, with 84 figures. Paris: Baillières et Fils.

A DICTIONARY even of pure chemistry alone, like, *e.g.*, that of Watts, is in our days an arduous undertaking

but the programme of M. Bouant's work is much more daring, covering as it does the entire field of technical or applied chemistry. So far, however, as we can judge from the Part before us,—240 pages in double column,—the bulk of the articles will not be treated at very great length. To this, however, there are exceptions. Thus the ceramic or fictile art is treated of at great extent and illustrated with eleven figures, most of which refer not to the chemistry of pottery, but to its æsthetic aspect. On the other hand, the aniline colours can scarcely be said to have received a share of attention proportionate to their industrial importance. Aniline black is described in such a manner that its invention would seem due to one Lucas.

Under Acidimetry, Alkalimetry, and Volumetric Analysis we find mention of no indicators other than litmus, cochineal, and rosalic acid.

The metal cæsium and its compounds have been altogether overlooked.

Under Beer we find a remarkable statement:—"The bitterness of the hop is intensified by the addition of calumba root (*Cocculus indicus*) and *Faba amara*." It will surprise the reader to find *Cocculus indicus* given as a synonym for calumba root.

The fraudulent use of nitrobenzine in confectionery is duly mentioned, but there is no reference to its occasional introduction into wines.

Under "Acaroid Resin," the product of *Xanthorrhea hastilis*, which yields picric acid on treatment with nitric acid, we find it stated that this might be an advantageous method for the production of picric acid. Surely the author must be aware that this process has been abandoned as less remunerative than the use of phenol as a raw material.

The article on Bleaching is relatively brief, and has the disadvantage of not being illustrated.

It seems confusing to hear fustic spoken of as "Bois de Brésil jaune," since it does not come from Brazil.

Under Spermaceti we find mention of a fraud, certainly disgusting and possibly dangerous, *i.e.*, the addition of adipocire,—a product of the decomposition, under peculiar circumstances, of human and other animal bodies.

It is scarcely possible to form, from this one Part, a full and fair notion of either the merits or the defects of the entire work. If, as the Preface announces, it will be completed within two years, it will not require the reiterated appearance of supplements.

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

Sir,—I propose to follow Mr. Allen's remarks on this subject in the same order as referred to in his letter (Chemical News, vol. lvi., p. 149).

I am quite aware that sesame oil is used in making butterine, but its use is restricted, chiefly on account of its price. Mr. Allen says that, "in America, cotton-seed oil is the fluid oil chiefly employed for the purpose in question; but I believe this is not the case in Europe, where sesame oil and arachis oil seem to be preferred." I know that cotton-seed oil is extensively used in America, and that some makers of oleomargarine in this country press their own cotton-seed for this purpose. I also know of more than one maker of butterine who use large quantities of cotton oil and nut oil. Although some other oils are suitable for this purpose, as regards freedom from taste and smell and non-liability to become rancid too soon, I think the only oils at present used are sesame oil, cotton oil, nut oil, and niger oil. Of these cotton oil is most largely used, as far as I am aware of.

Mr. Allen next refers to another paper of mine on the "Adulteration of Oils." I quote from this paper and emphasize the remark that, "with a few trifling exceptions, all that appears from time to time in our chemical journals may be found in Chateau's "Corps Gras Industriels" (1864) and Fontenelle's "Manuel d'Huiles" (1866). Mr. Allen then gives ten methods, and says that "all or nearly all of the foregoing methods of examining oils have been devised or perfected within the last twenty years, and the majority of them within the last eight or ten, and hence could not have been described, or even foreshadowed, in books published in 1864 and 1866."

I am willing to admit that Mr. Allen's acquaintance with the literature of the subject is, on some of these methods, far in advance of my own.

Method 2.—Ascertaining the saponification equivalents of oils. If Mr. Allen will refer to page 19 of Fontenelle's work (1886) I think he will admit that this method was decidedly foreshadowed in 1866.

Method 6.—I do not know who first proposed iodine, but the use of this reagent is given in Chateau's work already referred to. There is certainly a very little to claim in using bromine for iodine.

Method 8.—The rise of temperature noted by Maumené, when sulphuric acid is added to an oil was published in 1852, and as the results of Maumené and others occupy thirteen pages of the "Manuel" by Fontenelle (1866), I may be excused dealing with this method further.

Method 9.—The determination of glycerin, &c. The claim raised here ignores what we owe to Chevreul, who has been rightly styled the "father of fatty chemistry," and who indicated that the amount of glycerin from the same oil should be constant.

Method 10.—The determination of the higher alcohols in sperm and bottle-nose oils, and of hydrocarbon oils in fatty oils generally. On these points I am certainly not acquainted with a satisfactory method of procedure. Specific gravity, consumption of oil in a given time, under a fixed illuminating power, have been for many years in use; more recently their lubricating power and viscosity are taken as indicating the purity of oils as lubricants. Experiment in this direction is more eloquent than words. I have been informed of a Company who saves at least £300 per annum on sperm oil and about £800 per annum on ordinary lubricating oil. Analysis and experiment alone have led to this result.

I have no practical acquaintance with the other methods mentioned by Mr. Allen, except that I use a different reaction for the presence of free acids, and determine the specific gravities of substances likely to contain air, by methods which are reliable but not mentioned. I find that the separation of fatty substances from resins and rosin oils can be carried out by the method given on page 415 of Fontenelle's book, and is especially valuable when a sample of colza or refined rape oil is mixed with rosin oil. Chloride of sulphur will effect their separation perfectly.

I have found this reagent so reliable with some oils that I have no hesitation in rejecting an oil which does not give the characteristic result. The systematic application of this reagent is being studied and worked out by Mr. E. Bruce Warren, principally in connection with butter adulterations and substitutes.

I am quite aware of the imperfect way in which chloride of sulphur has been referred to by me. Mr. Allen says "my experience of chloride of sulphur leads me to believe it to be badly adapted for such a purpose, as in my hands the extent and rapidity of its action on an oil varied in an obscure manner under conditions apparently identical."

I shall be very pleased, as soon as the application of this test is properly worked out, to send particulars of the same to the Chemical News.

I may just add that there is a great difference in chloride of sulphur, and that there is a very curious difference in its action on different oils. The yellow chloride should be used, and diluted with bisulphide of car-

bon or petroleum spirit; about equal volumes will be convenient for general use, but a much higher dilution is necessary in the case of castor oil. The reaction sets in as the solvent evaporates, which takes place by spontaneous elevation of temperature, assisted, if necessary, by a very gentle heat.—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove,
Forest Gate, E.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 12, September 19, 1887.

The Reduction of Alumina.—G. A. Faurie.—We take two parts of alumina very pure and finely powdered, and make it into a paste with 1 part of petroleum. This paste, well beaten up, is mixed with one part of sulphuric acid. When the yellow colour is uniform and the mass homogeneous sulphurous acid begins to escape. The paste is then wrapped up in paper and thrown into a crucible heated to dull redness, above 800°, so as to decompose the petroleum. The flame is let go out and the crucible is cooled. The compact product obtained is carefully powdered and mixed with an equal weight of a metal in powder. This mixture is placed in a graphite crucible, well closed, and the crucible is heated to whiteness in a blast furnace. It is then let cool and opened. Among a black metallic powder there are found grains and alloys of alum nium. This process is applicable also to silica, lime, magnesia, &c.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., May, 1887.

Contributions to the Study of the Products of the Saccharification of Starch.—Dr. J. Effront.—The progress of the transformation of starch into sugar and dextrine differs according as it is effected by means of malt or by means of an acid. In saccharification by malt the starch molecule is split up into dextrine and maltose. Saccharification by an acid is characterised by the transformation of starch into dextrine, and that of the latter into glucose. The dextrines obtained by these two methods are not identical. Those resulting from saccharification by malt are polymeric; those resulting from the acid process are not so, but all have always the same rotatory power. In the acid process there is always formed maltose to the extent of 34 to 38 per cent of glucose. In saccharification by malt the formation of glucose is not regular. In liquids of low specific gravity glucose is formed if the infusion of malt employed is turbid. Dextrine is obtained in a state of purity on destroying the sugar by the lactic fermentation. For analysing the products of the saccharification of starch the author proposes a method which consists in destroying the sugars by ammonia and sodium hypochlorite, and determining the dextrine by the deviation of the liquid before and after treatment.

On the Homologues of Aniline and their Industrial Separation.—Dr. O. N. Witt.—The author remarks that there is a well-marked tendency in industrial chemistry to reject the heterogeneous products which were formerly used as starting-points; benzene, toluene, aniline, the nitrotoluenes, and toluidines are now required and produced in a pure state, and probably in a few years the xylenes, nitroxylines, and xylidines will also be demanded in states of isolation.

Manufacture of the Colouring-Matters of the Eosine Group.—Dr. Otto Muhlhauser.—The author gives here in full detail instructions for the manufacture of fluoresceine, soluble eosine, eosine B, eosine A extra, eosine orange, spirit eosine, safrosine, erythrosine B, soluble primrose, erythrosine G, and dianthine.

Analytical Detection of Saccharine.—From the CHEMICAL NEWS.

Synthetic Formation of Closed Carbon Chains.—Dr. W. H. Perkin.—From the *Journal of the Chemical Society.*

Composition of Neutral Quinine Chromate.—Dr. O. Hesse.—From the *Pharmaceutical Journal.*

Assay of Quinine Sulphate by Potassium Chromate.—Dr. O. Hesse.—From the *Pharmaceutical Journal.*

Determination of Carbon, Hydrogen, and Nitrogen, in Organic Matter in a Single Operation.—Paul Jannasch and Victor Meyer.—This paper will be inserted in full by opportunity.

On Calcium Borate.—B. Blount.—From the CHEMICAL NEWS.

MISCELLANEOUS.

An Appeal.—We feel justified in bringing the following case before our readers, believing that many will be glad to aid. The main facts are vouched for by Mr. R. Forbes Carpenter, of Prestwich, Manchester. It is right to add that the sufferer shrank from the idea of this appeal, and that the responsibility of it rests upon a few Fellows of the Chemical Society. Mr. Charles Moon was for six years Chemist in the Laboratory of the Spence Brothers Chemical Company, Limited. In 1884 the Works were closed, and at about the same time Mr. Moon—at the age of 31—became blind through rheumatism. He himself, his wife, and two children were thus rendered destitute. Some members of the Society of Chemical Industry came forward, and Mr. Moon tried first in Manchester, and afterwards in Birkenhead, to get a living by trade. These attempts have unfortunately failed, and the ill-fated family are now in urgent distress. Several ophthalmic operations have already been performed, and a few more will be necessary; but there is now every hope that before long Mr. Moon will recover his sight, and with it the power of supporting his family. Chemists will not allow a brother Chemist to sink under a misfortune which, however terrible, seems likely to be temporary, and we have no doubt assistance will be afforded. We shall be happy to take charge of subscriptions and forward them to the recipient.

New Work.—Messrs. Macmillan are about to publish a "Course of Quantitative Analysis for Students," by Prof. W. N. Hartley, F.R.S. The text-book consists of 44 exercises in mineral analysis practised by the students of the Chemical Laboratory of the Royal College of Science, Dublin. Water analysis, gas analysis, and assaying are not specially treated, as there are already works designed to teach these subjects, but the examples are selected with a view of teaching the principles of chemical analysis, beginning with very elementary determinations, and passing onward, step by step, to the analysis of complicated and refractory silicates.

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Fellow of, and Assistant-Professor of Chemistry at, University College, London.

J. and A. CHURCHILL, 11, New Burlington Street.

TO MANUFACTURING CHEMISTS AND OTHERS.

THE METROPOLITAN BOARD OF WORKS will meet at the Office of the Board, Spring Gardens, S.W., on FRIDAY, the 21st day of OCTOBER, 1887, at Twelve o'clock at noon precisely, and will then be prepared to OPEN TENDERS by parties who may be willing to contract for the supply of 500 tons of MANGANATE OF SODA.

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J. E. WAKEFIELD,
Clerk of the Board.

Spring Gardens, S.W.,
11th October, 1887.

American Exhibition closes October 31st.

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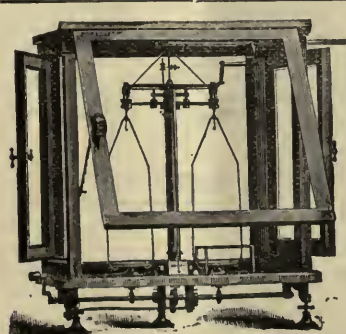

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THE CHEMICAL NEWS.

Vol. LVI. No. 1456.

THE RELATION OF SCIENCE TO THE STATE.

V.

We have shown, by an appeal to the stern logic of facts, that the position of Science in these realms is not what our national interests demand. In searching for the causes of this discreditable shortcoming we have referred to the hostility of the *cui bono* fraternity, whether utilitarians or ethicists. We have reminded our readers of the unremunerative character of original research under conditions prevalent in this country. We are told, indeed, by an author whom we have already quoted, that a scientific writer may earn from £2000 to £5000 annually by his works. Accepting, for argument's sake, this assertion, though it is sufficiently rose-coloured, we must note the proviso that the qualities required for popular scientific writing are the same as those which tell for works of fiction! How many of our most eminent *savants* possess this rare combination of faculties? How many of them could devote so much time and attention to mere pen and paper work? For how many of such authors would there be an opening?

Mr. Proctor mentions "scientific education" as one of the methods by which a man devoted to research may earn a livelihood. Doubtless this is the case in Germany, where a man climbs to the professorial chair by important and fruitful investigations which he has carried out, and where he is afterwards valued in proportion to the number of discoveries which he and his pupils bring forward. But in England all this is different: the Science teacher stands or falls not by the contributions to human knowledge effected in his school, but by the number of students whom he can get to "pass." And as research thus counts for nothing, it is valued at nothing.

Nor does the estimation in which even the most illustrious man of science is held by the nation or by Government at all compensate for the scantiness of more tangible rewards. There is no position of honour which can be won by research, and research only. The average John Bull is too apt to despise any man who does not make his fortune, and to argue that pursuits which do not enrich their especial followers can be of little value to the nation.

As for the honours which are supposed to be open to eminence of any kind, they appear to be withheld on principle from men of Science. Within the memory of the present generation four peerages have been awarded to Literature, and to Law a number greater than we care to calculate. Upon pure Science even a baronetcy or a knighthood is rarely bestowed. Yet it can scarcely be denied that a man like Faraday did more to raise England in the estimation of foreign nations than all the lawyers who ever pleaded at the Bar or gave decisions on the Bench.

But, leaving titles and orders on one side, there are other marks of honour which rarely fall to the lot of scientific men. Seldom are statues erected to their memory in any public place, and seldom are streets called by their names. As a very striking instance of cold indifference to the claims of Science we may single out the funeral ceremony of Charles Darwin at Westminster Abbey. No member of the Royal family was present, personally or by a representative. It may be said that such honours are barren; we cannot admit this assertion. They are an encouragement to the young student. Those of them which are not of a *post mortem* character are indirectly, but nevertheless decidedly, remunerative. The works of a titled *savant* would be more readily accepted in the "Row," and more eagerly bought by the public than if he had remained plain Mr. A. B.

Of course in all these points our national policy is in full contrast with that of our most formidable rivals. *They* find the encouragement of Science advantageous. We refuse to learn from their successes. Even in these innovating days we keep, in this respect, to our old paths. "Justice to Science" is not a catch-word which will influence a contested election, and—shall we say in consequence?—it is raised by neither party. There are, on both sides of the House, men who admit and regret our present position, but so far they show no disposition to do anything better than to institute new examinations to be "passed."

We fully admit that Government interference is a very delicate matter. Judging from the past we fear that there is too much truth in the humiliating confession made not long ago by the Earl of Derby, that such interference would be pernicious.

But Government interferes already—not in favour of, but against, research!

This interference takes place in a variety of ways. There is, at any rate, one direct enactment which seriously cripples investigations, not merely in biology, but in certain departments of chemistry.

Government has instituted, still upholds, and threatens to extend a system of higher education which is formally unfavourable to scientific research. Such research is in its spirit entirely opposed to a system which turns essentially upon competition. The true investigator never asks or cares whether he knows anything better than some other person. Such "other person" never crosses his thoughts at all. He sees before him merely the unsolved problems which Nature presents us, and he throws himself upon some one of these heart and soul. Said Prof. Rolleston—"One result of our present examination-system is that men who, . . . during the whole of their university career, are subject to the ordeal of examinations *in futuro*, . . . do not look upon what they have under study as so much truth, but look upon it as something to be reproduced upon paper. When a man is kept for many years of his life under that sort of training, he gets apt to look at all work whatever of the intellectual kind from the point of view of the examination merely. Men get demoralised by the process. They do not look at the truth for itself. They have no notion of pushing forward the elements of knowledge into some area into which nothing has been before."

Says Mr. Arthur Holmes, of Clare College (Cambridge)—"Examiners were the feature of this age, and they were getting intolerable."

Mr. Archibald Sayce, Fellow of Queen's College, Oxford, says:—"Competitive examination and original research are incompatible terms. The object of the one is to *appear* wise, the object of the other to be so."

Method Proposed for Destroying the Phylloxera—Dr. Clemm has patented the following process in most civilised countries:—He incorporates with the soil sulphides and carbonates which easily undergo decomposition, preferably those of potassium. Peat, which has been made to absorb sulphuric, nitric, or phosphoric acid, is then also introduced. The acid gradually acts upon the sulphide and the carbonate, liberating sulphuretted hydrogen and carbonic acid in the soil. These two gases, according to the experiments of Dr. Eyrich, of Mannheim, are rapidly and uniformly distributed, and prove fatal to the *Phylloxera* in its underground stage, as well as to Colorado beetles, field mice, moles, &c. The potash remains in the soil as a sulphate, nitrate, or phosphate. The only question is whether useful animals, such as earthworms, humble bees, carnivorous ground-beetles, &c., will not be destroyed also?

ON DEEP SEA DREDGINGS.

By THOMAS T. P. BRUCE WARREN.

IN the article which appeared in the CHEMICAL NEWS, vol. lvi., p. 151, on "The Relation of Science to the State," the following paragraph appears:—

"Another proof of our shortcomings may be found in the rarity of our scientific exploring expeditions by land or sea. Since the memorable voyage of the *Challenger* nothing of an extensive systematic character has been undertaken either under the auspices of Government or of private individuals. Nor must we forget that the staff of the *Challenger* was in part recruited abroad, and that the collections made and other crude results obtained were not entirely worked out at home. Some of them were committed for this purpose to Prof. Baury, of the University of Strasburg."

I have often wondered that simple chemical analyses should have been handed over to a foreign university, however distinguished. I would venture to say that any tyro in analysis, who was well up in accurate and careful manipulation, could have made the analyses of the "bottoms" picked up by this expedition with equal precision and with no less definite meaning for biological or geological renderings.

At present it passes my comprehension that a nation holding first rank as a naval power, possessing, too, the finest commercial fleet, and which has constructed and laid the submarine telegraph cables of the world, should be disposed to go to another nationality (which at this time could hardly boast of a mercantile marine) for the analyses of deep sea dredgings!

"Spectatum admissi risum teneatis amici?"

What warrant is there to justify the making of chemical science the scape-goat of the naturalists and microscopists who organised this part of the expedition.

A notion has gained currency that *hundredweights* of interesting dredgings have been brought to light, and that anyone getting a little of them *to work upon* may discover something which the *Challenger* scientists may have missed.

If there is any truth in this we have a right to ask whether it is fair or even honest to sacrifice the chemical reputation of this country to the mere sentiment of priority? Would it not have been wiser, at least, to have distributed portions of these dredgings to those who would appreciate their microscopical and chemical importance?

I should be sorry to say anything disrespectful of Germany; let us not forget Prof. W. A. Hofmann and what he did for us. I have no hesitation in saying that this country possesses naturalists, geologists, and chemists quite capable of doing what others have done for us; at at any rate, having formed an idea of what was intended to be carried out, there would have been no difficulty in training an efficient staff of operators in a few weeks, quite equal to any duties likely to arise on this expedition, or even of a higher intellectual stamp.

It is not too late to raise the status of our chemists as scientific men. Natural history and microscopy are at present hardly recognised as parts of a scientific curriculum, still those who are hostile to our reputation must admit that we are justly proud of our naturalists.

In making microscopes it would be affectation to place English and German instruments on the same level of excellence. Even the Americans turn out better objectives than the Germans. A fact worth noting is that, although the Germans have been working for some time past to improve the quality of their glass for objectives, we are able, even when using their own "metal," to turn out objectives much superior to their production.

I can imagine that a critic may say that this is no sign of superior handling; a man with an inferior instrument may, no doubt, do much better work than another working with a high class instrument. All I can say is, that the value of an observer in scientific microscopy is measured by the optical performance of his instrument.

Although there is a tendency to disparage our national merit in certain branches of science, I think that we need not fear who enter the lists against us as competitors.

What seems to me the main thing to be attained is the establishment of some channel for ventilating or discussing what may be called the "odds and ends" of science, subjects which, in fact, according to the etiquette of our learned sccieties, are not considered as suitable subjects.

If the Chemical Society were to have sections for considering chemistry in connection with branches of science which are not purely chemical, but which involve philochemical research, an important object might be gained, but on this matter others are better able to form an opinion than myself.

On a future occasion I propose to deal with this subject from a chemical point of view, although thermometry and microscopy can hardly be regarded as beyond range.

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Concluded from p. 167).

5. *On the Components of Samarium.*

THE name samarium was introduced by Lecoq de Boisbaudran for an element which was identical with Marignac's $Y\beta$, and which was also a constituent of the "old" didymium. According to measurements effected by Thalén with a preparation of Cleve's, samarium nitrate displays seven absorption bands in the easily visible part of the spectrum. As to the band $\lambda=445—437$ it is probably identical with the somewhat unsymmetrical lines given in the above tables as $\lambda=445{\cdot}1$ and $444{\cdot}7$. These were ascribed to didymium, as they were very strongly manifest in the spectra of many materials which were rich in the constituents of didymium, though no other samarium lines were visible.

The relative intensities of Thalén's other Sm lines will appear from the subjoined table. (See next page)

If we next observe $\lambda=416{\cdot}7$, this line occurs in many cases about as strong as $\lambda=477{\cdot}7$ and $\lambda=463{\cdot}2$. It is, however, surprising that $\lambda=416{\cdot}7$ is to be seen rather strong, strong, and even very strong, in the spectra of thorite from arendal, euxenite from the same locality (Fraction III.), and of holmium material, whilst no other Sm line is visible in the spectrum. In these mixtures of earths there is therefore a body whose nitrate produces in the spectrum merely the line $\lambda=416{\cdot}7$, and which we may call Sm_α; all the other samarium lines must be ascribed to a $Sm\beta$.

According to the above investigations we must, in place of erbium, holmium, thulium, didymium, and samarium, admit the existence of more than 20 elements. As the sum of the samarium spectrum, together with Auer's neodymium and praseodymium bodies, is equal to the spectrum of "old" didymium, just so the sum of the spectra of the above-mentioned components of the rare earths makes up the spectrum of the latter. In the above memoir we have proceeded on the principles according to which the compounds of samarium are spectroscopically distinguished from those of neodymium and praseodymium. According to our present knowledge about the samarium and didymium compounds we cannnot doubt that they are compounds of two distinct bodies. Were we to assume that the three different spectra of samarium, neodymium, and praseodymium did not correspond to the xistence of three completely independent bodies, but was

In the spectrum of the earths from—	λ = 559—556.	501·5—497.	477·7. (486—472).	463·2. (466—460).	416·7.	409.
Thorite from Brevig	—	—	Faint.	Faint.	Faint.	—
„ from Arendal, fraction of yttria earths.	—	—	—	—	Rather strong.	—
Wœhlerite	—	—	Faint.	Very faint.	Very faint.	—
Cerite of Bastnäs	—	—	Faint.	Very faint.	Faint.	—
Samarium material	Faint.	Rather strong.	Very strong.	Very strong.	Very strong.	Faint.
Fergusonithe of Arendal { Fract. I.	—	—	—	Very faint.	Very strong.	—
„ III., IV...	—	—	—	—	Rather strong.	—
„ V.	—	—	—	—	Rather faint.	—
Fergusonite of Ytterby	—	—	—	Very faint.	Strong.	—
Euxenite of Hitterö { Fract. I.	—	—	Strong.	Strong.	Very strong.	—
„ IV.	—	—	Faint.	Strong.	Very strong.	—
„ VII...	—	—	Very faint.	Rather strong.	Rather strong.	—
„ VIII.	—	—	—	Faint.	Rather strong.	—
„ X.—XI.	—	—	—	—	Faint.	—
Holmium material	—	—	—	—	Very strong.	—
Euxenite of Arendal { Fract. I...	—	—	—	Rather faint.	Strong.	—
„ III.	—	—	—	—	Strong.	—

due to three different combinations of only two independent bodies which should depart too far from the basis of facts, and should be obliged to call to help many hypotheses. The same would be the case were we to assume, *e.g.* that holmium consists not of 7 but only of 2 components. Such hypotheses would have a very arbitrary character. Hence we have been guided by the simpler views which, during the last ten years, have proved so fruitful in the decompositions and separations of the gadolinite and cerite earths.

The above accounts of the spectra of the earthy mixtures, may perhaps give hints in what minerals this or the other rare earth may be found in relatively considerable quantities. The authors then give the accompanying conspectus of all the 40 lines observed in the above researches in the spectra of the nitrate solutions of rare earths.

As for the position of the elements of the rare earths in the periodic system, they probably belong chiefly to the middle series; perhaps in time it may be necessary to increase the number of these series. According to Mendeleeff elements closely allied to each other should find their place in the middle of the system, those most analogous being the closest together. Further speculations would be premature. The authors finally express the hope that many chemists may be found to take a share in cultivating a department which requires the united efforts of many investigators.—*Berichte der Deutch. Chem. Gesellschaft*, Vol. xx., Part 12, p. 2134.

Wave-lengths of maximum darkness.	Symbols of elements.	Remarks.
728·3	Di_α	In spectra of ytterbia mother-liquors, and of the euxenite of Arendal, Fract. VIII.—XIV.
716·4	?	
708·0	Di	
690·5	Di_κ	
684·0	Tm_α	
679·4	Di_β	
654·7	Er_α	
640·4	X_α	
626·1	Di	
591·5	Di	
579·2	Di_γ	
575·4	Di_γ	
558·6	Sm_β	
542·6	X_β	In spectra of holmium materials; in earths from wœhlerite and thorite of Brevig.
539·9	?	
536·3	X_γ	
533·6	?	In euxenite of Hitterö and fergusonite of ytterby.
531·3	Di	
530·0	Di	
525·2	Di_κ	
523·1	Er_β	
521·5	Di_δ	
514·6	Di	
512·2	Di_ϵ	
500·4	Sm_β	In spectra of earths from wœhlerite and thorite of Arendal.
488·8	?	
485·5	X_δ	
482·0	Di_ζ	
477·7	Sm_β	
474·5	X_ϵ	
469·0	Di_η	
465·0	Tm_β	
463·2	Sm_β	
452·6	X_ζ	
445·1	Di_θ	
444·7	Di_ι	
434·0	Di_κ	
428·5	X_η	
416·7	Sm_α	
409·0	Sm_β	

ON THE COMPOSITION OF WATER BY VOLUME.*

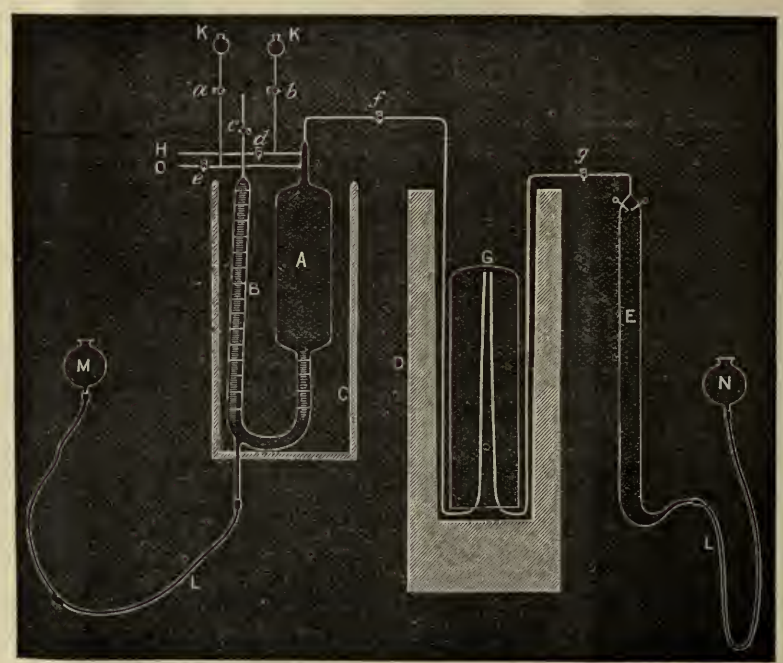
By ALEXANDER SCOTT, M.A., D.Sc.

In 1805 Gay-Lussac and Humboldt published their classical researches on the composition of the atmosphere, and to them we are indebted for our knowledge of the proportion by volume in which hydrogen and oxygen combine to form water. Without this knowledge the determination of the relative densities of the two gases would be of no use in fixing or checking their atomic weights. This is often overlooked, and Avogadro's law taken as absolutely true for these gases at ordinary temperatures and pressures. That this cannot safely be assumed is conclusively proved by the researches of Regnault, Amagat, and others on the effects of change of temperature and pressure upon them. Not only do they not follow Boyle's law as usually understood, but their deviations from it are in opposite directions, hence it can only be by the merest chance that at our ordinary temperatures and pressures the combining volumes should be exactly two of hydrogen to one of oxygen. Moreover, when we consider that it is more than eighty years since these researches were carried out, that the instrument used in all the measurements was Volta's eudiometer, and that the gases were collected and measured over water

* A Paper read before the Royal Society, June 16, 1887.

Experiment.	A. Measured volumes of		B. Residue after explosion.				C. Combining volumes, impurity being calculated as being in both in same proportion.		D. Combining volumes, all impurity being supposed to be in the oxygen.		E. Calculated from column C, 1 volume of oxygen combines with the following vols. of hydrogen.	F. Calculated from column D, 1 volume of oxygen combines with the following vols. of hydrogen.	G. Impurity in gas used (total).
	Hydrogen.	Oxygen.	Total.	Oxygen.	Hydrogen.	Impurity $N+CO_2$.	Hydrogen.	Oxygen.	Hydrogen.	Oxygen.			
I.	3757·1	1919·5	39·5	36·8	—	2·7	3755·3	1881·8	3757·1	1880·0	1·9956	1·9984	$\frac{1}{1434}$
II.	3848·1	2028·7	104·4	94·5	—	9·9	3841·5	1930·9	3848·1	1924·3	1·9894	2·0000	$\frac{1}{515}$
III.	3902·0	2085·7	131·3	128·7	—	2·6	3900·3	1956·1	3902·0	1954·4	1·9934	1·9965	$\frac{1}{2870}$
IV.	3672·6	1921·9	63·4	35·0	—	28·4	3653·7	1877·4	3672·6	1858·5	1·9460	1·9760	$\frac{1}{405}$
V.	3841·5	1915·7	44·1	—	32·7	11·4	3801·2	1911·9	3808·8	1904·3	1·9882	2·0000	$\frac{1}{550}$
VI.	3667·9	1868·8	56·9	—	28·1	28·8	3620·6	1857·2	3639·8	1840·0	1·9494	1·9781	$\frac{1}{501}$
VII.	3685·9	1876·5	22·2	12·8	—	9·4	3679·6	1860·6	3685·9	1854·3	1·9776	1·9877	$\frac{1}{800}$
VIII.	3649·1	1891·5	61·1	52·8	—	8·3	3643·6	1835·9	3649·1	1830·4	1·9846	1·9936	$\frac{1}{685}$
IX.	3942·6	1997·0	18·8	12·5	—	6·3	3938·4	1982·4	3942·6	1978·2	1·9867	1·9930	$\frac{1}{940}$
X.	3861·3	1967·3	30·5	24·5	—	6·0	3857·3	1940·8	3861·3	1936·8	1·9875	1·9936	$\frac{1}{685}$
XI.	3799·7	1930·2	29·1	23·4	—	5·7	3795·9	1904·9	3799·7	1901·1	1·9927	1·9986	$\frac{1}{1018}$
XII.	3857·1	1948·2	19·4	15·2	—	4·2	3854·3	1931 6	3857·1	1928·8	1·9954	2·0000	$\frac{1}{1394}$
XIII.	3845·4	1954·9	25·0	20·5	—	4·5	3842·4	1932·9	3845·4	1929·9	1·9880	1·9926	$\frac{1}{1378}$
XIV.	3780·4	1907·4	12·2	9·0	—	3·2	3778·3	1897·3	3780·4	1895·2	1·9910	1·9950	$\frac{1}{1786}$
XV.	3898·6	1963·5	10·9	8·8	—	2·1	3897·2	1954·0	3898·6	1952·6	1·9945	1·9966	$\frac{1}{2801}$
XVI.	3910·2	2003·2	44·9	40·4	—	4·5	3907·2	1961·3	3910·2	1958·3	1·9920	1·9969	$\frac{1}{1388}$
XVII.	3965·5	2011·5	25·6	21·6	—	4·0	3962·9	1988·6	3965·5	1985·9	1·9928	1·9968	$\frac{1}{1211}$
XVIII.	4012·6	1975·9	79·3	—	77·2	2·1	3934·0	1975·2	3935·4	1973·8	1·9917	1·9940	$\frac{1}{2587}$
XIX.	4078·7	1964·0	184·7	—	178·2	6·5	3896·1	1961·8	3900·5	1957·4	1·9860	1·9926	$\frac{1}{942}$
XX.	4095·3	2008·6	87·8	—	84·5	3·3	4008·6	2007·5	4010·8	2005·3	1·9968	2·0000	$\frac{1}{1838}$
XXI.	3904·8	1964·5	27·8	—	12·5	15·3	3882·1	1959·4	3892·3	1949·2	1·9813	1·9968	$\frac{1}{504}$

The unit volume taken is that of a grm. of mercury at 16° C. The gaseous volumes are reduced to 0° C. and 760 m.m. pressure. The residue given in B was in all cases analysed by explosion with H or O. Column C gives the combining volumes if we assume the hydrogen and oxygen to be equally pure. Column D of course gives a maximum value to the ratio of the volume of hydrogen combining with 1 of oxygen. The gaseous impurity was almost entirely nitrogen with small quantities of carbon dioxide.



and so contained the impurities to the extent of 0·4 per cent in the oxygen and 0·6 to 0·8 per cent in the hydrogen used, a re-determination of this ratio with the greatly improved means for attaining accuracy now at our command seemed to be of extreme importance. The exact ratio as given in the memoir referred to is 199 89 volumes to 100 volumes of oxygen, and this the authors say is almost exactly as 2 : 1.

To arrive at greater accuracy the author of this note has given especial attention to the following points :—

(1.) The preparation of purer gases.
(2.) The use of larger volumes.
(3.) The measurement of both gases in the same vessel
(4.) The analysis of the residue after explosion and determination of the impurity in each experiment.

These ends were more or less satisfactorily attained by the use of apparatus employed, which was entirely of glass with the exception of the junctions at H and O. The gas generators contained only small volumes of gas, and could easily be exhausted by means of the apparatus itself. It is evident that by filling A and B with mercury, completely closing all the stopcocks, and then lowering M and opening *e*, the air in the oxygen generator would be in great part drawn into A; on now closing *e* and raising M this air could be expelled by opening *f*. By repeating this several times an almost perfect vacuum could be produced. Before collecting the gas for the experiments, after exhausting the air gas was evolved and exhausted, and this again repeated. The gases were measured, saturated with moisture, and after measurement were expelled into G; from this they were drawn into E and exploded, and the residue measured in a small tube and analysed by explosion with either hydrogen or oxygen as required. The results of every experiment made are given in the accompanying table, from which it will be seen that in no case, even when the maximum value is given to it, does the ratio exceed 2 vols. of hydrogen to 1 vol. of oxygen, although in four cases it is exactly 2 : 1.

The mean of the twenty-one experiments gives the ratio—

1·9857 : 1 from Column E.
1·9941 : 1 ,, F.

Excluding experiments IV. and VI., in which the gases contained much impurity, we get the ratio—

1·9897 : 1 from Column E.
1·9959 : 1 ,, F.

Taking experiments I., III., XV., and XVIII., in which the purest gases were used, we get—

1·9938 : 1 from Column E.
1·9964 : 1 ,, F.

or taking experiments I., III., XIV., XV., XVIII., and XX. we get—

1·9938 : 1 from Column E.
1·9967 : 1 ,, F.

Taking as the most probable ratio 1·994 : 1, and the density of oxygen referred to hydrogen as 15·9627, we get the atomic weight of oxygen as 16·01.

The oxygen was in each of the first twenty experiments prepared from potassium chlorate, and in the twenty-first from mercuric oxide prepared from the nitrate. The hydrogen was in each case prepared by electrolysis. The water produced was free from any acid reaction, and no trace of the oxides of nitrogen could be detected.

ANIMAL TANNIN.

By M. VILLON.

Hitherto there have been known only vegetable tannin with its 800 varieties, and synthetic tannin or digallic acid, not to speak of the so-called mineral tannin obtained from coal, peat, &c. The author has for a long time sought for an animal tannin,—*i.e.*, one formed in the organism of an animal, and appearing either in its secretions or in its tissues. Having been engaged with the weevils, well known from the damages which they occasion in granaries, he sought for tannin, knowing that as far back as 1810 M. Penunt, of Lyon, had found gallic acid in these insects.

The corn weevil (*Calandra granaria*) is a Coleopterous insect of about 3 millimetres in length, and of a maroon-brown colour. These insects were first killed by exposure to the fumes of chloroform, then ground up and digested for an hour in boiling alcohol at 90 per cent. The extract is decanted into a retort and evaporated down on the water-bath to a syrup, and finally dried in a capsule. The residue is taken up in acetic ether at 50°; the liquid is filtered, diluted with half its volume of water, and precipitated by means of ammoniacal zinc acetate, prepared by dissolving zinc acetate in liquid ammonia diluted with half its volume of water. The first and the last portions of the precipitate are rejected. The precipitate thus obtained consists of zinc tannate, other substances—such as gallic, ellagic acids, phlobaphine, albumenoids, and pectic principles—remaining in solution.

The precipitate is then suspended in water to which oxalic has been added sufficient to throw down all the zinc, The mixture is heated nearly to a boil whilst stirring. The tannin remains in solution; the liquid is evaporated to a syrup in a vacuum at a temperature of 50° to 60°. Five hundred parts of weevils yielded fifteen parts of pure tannin.

Animal tannin (fracticornitannic acid) appears in the form of small reddish yellow scales, soluble in water, aqueous ether, alcohol, chloroform, &c. It possesses all the general properties of the tannins, precipitating gelatin, albumen, and dissolved caseine, and being absorbed by animal tissues. It precipitates the natural and artificial alkaloids and gives a bluish black colouration with ferric salts. Its analysis leads to the formula $C_{28}H_{16}O_{16}$. Sulphuric acid splits it up into glucose, gallic acid, and an amorphous red product analogous to phlobaphene.—*Bull. de la Soc. des Elèves de M. Fremy.*

PROCESS FOR OBTAINING THE RARE EARTHS OF THE CERIFEROUS CLAYS OF HAINSTADT.

By Dr. JONES RUDOLPH STROHECKER.

Since the investigation of the material has passed the primitive stage described in my two first memoirs (*Journ. Prakt, Chemie*, 1886, pp. 132 and 260), and in consequence of criticism has been submitted to a special re-examination (Keim, *Techn. Mittheilungen*, Munich, 1886, Nos. 23 and 24, and *Chemisch. Centralblatt*, Sept. 1, 1886), the reason has come to light why in most cases cerium cannot be separated out in the ordinary manner, and it became in consequence requisite to find a satisfactory method for obtaining the rare earths of the cerite clays.

The cause why cerium generally escapes separation, and even observation, is the presence of ferric oxide,—if a cerite clay contains more than about 0·5 per cent of this substance, oxalic acid and potassium sulphate produce not the ordinary cerium deposite, but others rich in iron. The oxide obtained by means of caustic potassa from the alum precipitate is of a leather-brown, and retains this colour on ignition. It behaves like a very intimate combination of the oxides of iron and cerium, but its constitution is as yet unknown. This substance seems to have been at once taken for iron oxide by many chemists.

Very numerous separation-experiments were therefore undertaken, among which there occurs a crystallisation of cerous sulphate. Pointed pyramids were formed from a sulphuric solution of ferriferous Hainstädt cerium, and were examined by me and by a member of the University of Berlin. As further accelerated experiments in crystallisation gave a yield of crystals,—abundant, indeed, but not free from iron,—a purely chemical process had to be sought for. The following was found the most serviceable:—

The red cerite clay (No. 1) is boiled with pure hydrochloric acid until it is decolourised. The bituminous material is boiled for the same length of time. The fil-

trate is treated with potassa for the removal of silica, alumina, and glucina, and the washed precipitate (consisting of ferric oxide, cerium and lanthanum oxides, and possibly didymia, yttria, lime, magnesia, and phosphates) is re-dissolved in hydrochloric acid and mixed with potassium sulphide (not ammonium sulphide); phosphoric acid passes into solution, and all the earths are precipitated. They are again taken up in hydrochloric acid; from the solution all the iron and cerium are separated by means of sodium acetate and hypochlorite, whilst all the other earths remain in solution.

The precipitate of iron and cerium oxides, mostly of a leather colour, is dissolved in hydrochloric acid; the solution is mixed with an excess of ammonium chloride, well boiled, and completely reduced with sulphurous acid, neutralised with ammonia, and the ferrous oxide thrown down with ammonium sulphide. The filtrate contains the double chloride; it is evaporated to dryness and the residue ignited, when there remains Ce_3O_4, of a lemon colour (atomic weight 92·1). The filtrate, freed from iron and cerium, but containing the remaining earths, is boiled with excess of ammonium chloride to form the double compounds of lanthanum, yttrium, and possibly didymium. Lime is then removed with ammonium carbonate, and the filtrate is boiled with potassa until ammonia is expelled. The precipitate is boiled with oxalic acid, when lanthanium, yttrium, and didymium oxalates are deposited and magnesia dissolves. The oxalic precipitate is ignited, dissolved in sulphuric acid, and forms alums. That of lanthanum and that of didymium, if present, remain on the filter; that of yttrium is found in the filtrate.

If it is desired to recover that part of the glucinum which was extracted with hydrochloric acid and separated along with alumina, the alkaline solution of the two earths is almost neutralised with pure hydrochloric acid, and finally with acetic acid, heated to a boil, and the precipitate after previous purification from silica is extracted with ammonium carbonate.

The questions whether we have here to do with a "neocerium," and what is the composition of the leather-coloured oxide and of the blue substances formerly described, must for the present be left to others whom it may interest.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING SEPTEMBER 30TH, 1887.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To GENERAL A. DE COURCY SCOTT, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, October 7th, 1887.

SIR,—We submit herewith the results of our analyses of the 181 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from September 1st to September 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The amount of organic matter in the water supplied to the metropolis during September was exeeedingly small, the results recorded day by day being marked by great uniformity. Thus the organic carbon in the Thames-derived waters was, on an average of numerous samples, 0·125 part per 100,000 parts, the oxygen required to oxidise the oxidisable matters present in the water being about 3-100ths of a grain per gallon. The colour, moreover, of the waters, as shown by the colour meter, was excellent. A few samples of the East London Water Company's supply were recorded as "very slightly turbid." This condition, however, in no respect interfered either with the general purity or with the wholesomeness of the supply. Without exception, the condition of the water supplied to the metropolis during September was entirely satisfactory.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

ON PHOTOBROMIDE AND PHOTOIODIDE OF SILVER.

By M. CAREY LEA, Philadelphia.

Photobromide of Silver.

THIS substance is formed, for the most part, by the same reactions as the corresponding chlorine salt.

It is not, however, to be supposed that all reddish-brown substances resulting from the action of reducing agents on silver bromide, are the photo-salt. By reduction AgBr may yield a brownish-coloured form of silver, which, mixed with unreduced AgBr, may form a substance resembling the photo-salt, but having none of its properties. The two are easily distinguished by the action of cold nitric acid, which, added to a brown mixture of AgBr and Ag, quickly dissolves the silver, leaving AgBr. On the photo-salt it has no action.

A beautiful variety of photobromide is easily obtained by dissolving silver nitrate in ammonia and adding it to ferrous sulphate previously mixed with solution of soda. Then KBr is added dissolved in dilute sulphuric acid, until the mixture has a strong acid reaction.

Sometimes this method gives immediately a fine purple, sometimes a brown product. But in either case, after washing and cautiously heating with dilute nitric acid, a beautiful purple results. Much care is needed in the nitric acid treatment, or particles of yellow bromide will form.

A specimen obtained in this way gave figures indicating 7·25 per cent of sub-bromide. Each specimen, however, varies in composition, often very materially.

I subsequently found it desirable in some degree to vary the method, and to determine the best proportions in which the materials were used, to obtain a constant product. That which I prefer to use is as follows:—

Six grms. of silver nitrate are to be dissolved in 200 centimetres cube of water, and ammonia added until the precipitated oxide re-dissolves easily. Twelve grms. of ferrous sulphate are dissolved in 200 c.c. of water, and the silver solution is poured into this. Then four grms. pure caustic soda dissolved in 50 c.c. of water are added, let stand a few minutes, then five grms. of KBr dissolved in a little water. Finally, dilute sulphuric acid until the whole has a strong acid reaction.

This product, well washed and then heated cautiously with nitric acid 1·36 diluted with five times its bulk of water, gives photobromide of a shade of royal purple, extremely beautiful.

Notwithstanding its fine colour it proved to contain but little sub-bromide, not quite one per cent (0·98 p.c.).

Various other methods may be employed. Silver bromide may be dissolved in ammonia and be treated first with ferrous sulphate and then with dilute sulphuric acid. This method, which is very good with the chloride, is less available for the bromide, because of the less solubility of the normal bromide in ammonia, so that although the product is good it is small in quantity.

Very good results are obtained by dissolving silver phosphate, nitrate, and probably almost any other salt of silver in ammonia, adding ferrous sulphate, and after two or three minutes hydrobromic acid.

Potash bromide and cupric sulphate may be made to act on metallic silver in fine powder, but the product is contaminated with much copper, difficult to get rid of.

When AgBr is treated with sodium hypophosphite a brown or brownish-purple form of photobromide is obtained, which seems to be more easily decomposed by nitric acid than most other forms of this substance.

Potash or soda with oxidisable organic substances made to react on silver nitrate and then treated with HBr gives the photobromide. With soda and milk-sugar or aldehyd a rose-coloured or pink product is generally obtained.

Reactions.—In strong solution of potassic iodide it dissolves, and this solution by dilution lets fall pale yellow normal bromide. With a weaker solution it becomes somewhat lighter in colour.

With acid ferric sulphate there is no action in the cold, but with a few minutes boiling the photobromide is converted into bright coloured normal bromide.

In sodium hyposulphite it dissolves, leaving a little black residue of silver.

With ammonia the action at first seems slower than is the case of the corresponding chloride, and if the ammonia is poured over the photobromide in small quantity, it may seem to be without effect. But the photobromide shaken well up in a test-tube with a large excess of ammonia is almost instantly blackened.

Exposed to light, the red shades of photobromide darken with great rapidity. Placed alongside of the corresponding chloride the contrast is very striking:—a strong image forms on the bromide long before anything appears on the chloride; nevertheless, if these two films are thrown into a developing solution, the chloride on which nothing could be seen, gives a vigorous positive development, while the bromide which already showed a strong positive image develops a negative one. The details of this reverse development have been already considered in another paper.

As respects the direct effect of light unaided by development, the contrast between its action on the normal haloids and on the photosalts is very striking. If a rose-coloured photobromide and some normal bromide are exposed side by side, the normal bromide (formed in presence of excess of alkaline bromide) darkens but very slowly, while the photobromide is quickly acted on. I have seen deep purple photobromide change to brown all over its surface with less than five minutes exposure to diffuse light in the middle of a room, an amount of exposure which would scarcely have produced a visible effect on normal bromide formed in presence of excess of KBr.

When photobromide is exposed to the spectrum it shows the same difference in sensitiveness, and darkens more rapidly than photochloride. But it gives little indication of colour.

When exposed under coloured glass photobromide gave distinct indications of reproducing colours, but much less favourably than photochloride. Under green glass it became bluish, under blue greenish, under yellow glass it bleached, and under red glass the red of the photobromide remained unchanged.

Photoiodide of Silver.

The most characteristic colour of this substance seems to be a fine rich purple. It is obtained in much the same way as the corresponding chloride and bromide, with this limitation, that an excess of alkaline haloid must not be present, as the photoiodide is quickly destroyed by it. The iodine salt differs much more from the bromide than does the bromide from the chloride, and two striking distinctions are, its easy decomposition by its own alkaline salt, and its action with ammonia, as will appear beyond.

A very easy and satisfactory method of obtaining the photoiodide is the following:—Silver is to be reduced from the nitrate or chloride in fine powder in any convenient way; I have usually employed Levol's method. To a solution of potash iodine is to be added until the liquid becomes almost black. This iodine solution is to be diluted and poured over the silver by degrees, keeping the silver constantly agitated, until the whole mass becomes clear bright purple.

Any excess of silver present may be removed by boiling with dilute nitric acid, but this operation requires far more circumspection than in the case of the corresponding chlorine and bromine products. The acid (1·36 was used) must be diluted with twelve or fifteen times its bulk of water, and the boiling must be very short, otherwise the photoiodide is converted into normal yellow iodide.

Another method by which it may be obtained is to add ammonia to silver nitrate in considerable excess, and to pour this into solution of ferrous sulphate. Potassic iodide is dissolved in very dilute sulphuric acid and added till the mixture has a sharp acid reaction. It is necessary to observe that the KI added must be somewhat short of a proportion equivalent to that of the silver. Any excess of silver may be removed in the manner already explained.

Different specimens of the purple product in this way obtained gave various amounts of Ag_2I from 0·64 per cent to 4·63. The same remark made as to the meaning of these determinations in reference to the other haloids applies to this.

The method of roasting silver oxide until it is black and acting on it with the hydrogen acid of the halogen, which works well in the case of the chloride, does not answer well for the iodide.

When silver iodide is boiled with solution of sodium hypophosphite it gives a brown product, evidently indicating that reduction to some extent has taken place; the hypophosphite solution may or may not show traces of iodine. The colour of the silver iodide may show a very marked darkening, and yet the solution may give no trace of iodine by the most delicate reagents.

This was very difficult to explain until I found that silver iodide has the property of taking up and retaining small portions of iodine, a reaction not very surprising in view of the tendency I have found in silver haloids to take up foreign substances of very various natures, and also of the facility with which iodine is taken up by alkaline iodides. This property in silver iodide was verified by shaking up portions of freshly-precipitated and still moist AgI with iodine solutions. Alcoholic solution of iodine diluted until it has a pale sherry wine colour is quickly decolourised by AgI, and the same thing happens with a very dilute solution of iodine in KI, which in a few minutes becomes as colourless as water.

This reaction I found particularly interesting, for it not only explained the action of hypophosphite in the case just mentioned, but also gave a clue to the cause of a phenomenon I observed more than twenty years ago, and which then and long afterwards seemed to me an unanswerable argument in favour of the physical nature of the latent image.

At the time referred to I formed films of pure silver iodide entirely isolated from foreign matter by reducing metallic silver on plates of ground glass, iodising them with alcoholic solution of iodine, or with Lugol's solution, then washing most thoroughly under a tap for hours. When these films of silver iodide were exposed to light they received an invisible image which could be developed. But these invisible images, if the plates were laid aside in the dark, had the property of fading out in a few days

or weeks, then could no longer be developed, but the film could receive a fresh image. This seemed an unanswerable proof of the physical nature of the latent image, at least on silver iodide. The argument was:—If the production of this latent image is the result of chemical action involving the loss of iodine by the silver salt, how then is this iodine recovered when the image fades out? It it is formed of subiodide, where does this latter substance get back its iodine to return to the normal form, as it unquestionably does?

No answer could be given then or after, and this experiment, repeated and confirmed by others, has always seemed the strongest support of the physical theory. When, however, it appears that silver iodide can take up iodine and hold it, the course matters follow becomes evident. By the action of light a very small quantity of subiodide is formed, and combines with the normal to form photoiodide. The iodine set free evidently does not pass off, but remains combined with neighbouring molecules of AgI, and in the dark gradually re-combines with the photoiodide, re-converting it to normal AgI. In this retention the lower tension of iodine, as compared with bromine and chlorine, no doubt plays its part.

In thus explaining away the fading out of the latent image on silver iodide, the last argument in favour of the physical theory is destroyed, while the chain of proof supporting this new explanation, that the latent image consists of normal haloid combined with its own sub-salt, remains unbroken.

Reactions. — When ammonia is poured over purple photoiodide of silver, the colour quickly passes to a salmon and then, even after some days, seems to undergo no further change. Of separation of metallic silver, as in the case of the corresponding chloride and bromide, there is no trace.

In sodium hyposulphite it dissolves slowly, leaving a slight but distinct residue.

Dilute nitric acid mixed with dilute solution of KI slowly but completely converts it to normal silver iodide.

Light acts slowly upon it, changing the colour to greenish-grey.

I have already spoken of the remarkable manner in which light acts reversely by development on photobromide. On photoiodide the effect is usually the same as on photochloride, viz., the action is direct. But occasionally it reverses and the exposed part comes out lighter in development than the part that has not been exposed. In this respect the behaviour of the iodine compound is intermediate between that of the chlorine and the bromine.

Note in Conclusion.

The investigations of which the preceding pages are the result, are still unfinished. I have very lately observed the formation of another group of silver haloids quite different from the photo-salts. The members of this new group are deeply coloured, purple or red, not unlike the photo-salts, but are sharply distinguished from them by very different reactions. The photo-salts are unaffected by cold strong nitric acid; these new salts are by very dilute acid instantly converted into a pale pink substance, which appears to be a photo-salt. But the most striking difference is in the action of ferric chloride. A strong solution of this substance shows no action with the photo-salts unless left in contact for many hours or days. But these new haloids are instantly converted by it into what is apparently light pink photo-salt.

So energetic is this action that a solution of ferric chloride containing one part only to a thousand of water quickly attacks these dark purple salts and decolourises them. Such a solution might remain indefinitely in contact with the substances I have called photo-salts without affecting them.

Other differences exist. So far as I have yet been able to observe these new haloids are formed pure, whereas the photo-salts are almost always contaminated with either free silver or free subsalt, or both. As yet there has been no time to fix with exactness their mode of formation or their properties, which I hope to do at a future day.—*American Journal of Science*, June, 1887.

NOTICES OF BOOKS.

A Treatise on the Animal Alkaloids, Cadaveric and Vital; or the Ptomaines and Leucomaines Chemically, Physiologically, and Pathologically considered, in Relation to Scientific Medicine. By A. M. Brown, M.D. With an Introduction by Prof. Armand Gautier, of the Faculté of Medicine of Paris, and Member of the Académie of Medicine. London: Baillière, Tindall, and Cox.

We have here a work which was really needed. Notices of the ptomaines, of their behaviour, and of the means for their recognition, may be found scattered through our medical and toxicological literature; but we find here a systematic view of the whole subject.

Dr. Brown points out the importance of the recognition of the animal alkaloids as overturning one of the fancied distinctions, chemical and physiological, between the animal and the vegetable worlds. He gives a brief history of the discovery of these remarkable substances, and passes on next to explain their origin. The distinction between the ptomaines or cadaveric alkaloids, formed after death, and the leucomaines or vital alkaloids, generated during life, is clearly shown. A body of the former class is said to be "the residual skeleton of the proteine molecule which has undergone continuous disintegrative action, the ultimate terms of which are represented by the pyridic bases."

As methods applicable for extracting these ptomaines from decomposing animal remains, we find described the Stas-Otto process, that of Pouchet, the earlier and the later methods of Gautier, and that of Brieger.

In the section discussing the chemical properties of the ptomaines we find them classified as belonging to two distinct series, the pyridic and the hydropyridic. It is remarked that some of these bases are liquid, volatile, odorous, and contain no oxygen, whilst others are solid, crystalline, and oxygenous. The odour of the liquid ptomaines is said to occasionally remind the observer of musk or of odoriferous plants. Says Dr. Brown:—"It is possible that between the products of the bacterial putrefaction of animal tissues and the perfumes of the vegetable cells of flowers, similarity is not altogether accidental." This remark is suggestive; perfumes are recorded as having been observed as given off from the bodies of persons dying of acute disease, and occasionally the excrements of ruminant animals are found to give off a scent very similar to musk.

The author shows that the reaction by which Selmi, Brouardel, and Boutmy thought the cadaveric bases might always be distinguished from the vegetable alkaloids,—*i.e.*, the reduction of potassium ferricyanide by the former—is not trustworthy. Morphine, atropine, and certain other vegetable bases, instantaneously decompose a mixture of potassium ferricyanide and ferric chloride.

The oxygenous animal bases are described as linking the ptomaines to the leucomaines.

As regards the physiological action of these bodies, it is shown that hydrocollidine is almost as powerful as the venom of the cobra. The medico-legal—it would be surely more correct to say the chemico-legal—bearings of the subject are next taken into consideration. There is no one reagent known which will at once distinguish any and every ptomaine from any and every vegetable alkaloid. But no ptomaine presents all the reactions of any one of the deadly plant bases. Hence Hugounenq holds that it is always possible to distinguish between a vegetable alkaloid introduced into the system during life from a ptomaine developed after death."

But how if the ptomaine has been introduced during life? This is a possible case. Among the methods used

by certain savages of poisoning their daggers, arrows, &c., one is to leave the points in contact with certain putrescent animal matters. It is at least possible that the old Italian poisoners had an empirical knowledge of these bodies, which they seem to have obtained from the carcass of a bear,

The second part of the work treats of alkaloids, generated in the animal system during life, frequently poisonous and yet harmless, because in health they are decomposed or eliminated as fast as produced. We are here introduced to views of the profoundest importance in physiology, and which will bear practical fruit in the medicine of the future.

But whilst we gladly admit the value of this work,—which we have read, we trust not without profit,—we cannot overlook two blemishes; it is disfigured with printing-faults to an unusual extent, and is not written in very good English. Thus we find "trimethylamine" transmuted into "trymethylamine;" the name "Dragendorff" figures as "Drogendorff," "Drugendorff," and twice as "Draggendorff;" "glycocoll" becomes "gylcocolle;" "fibrine" is made into "febrine;" "phosphotungstic acid" is twice given as "phosphotungestic acid" and once as "phosophate-ungestic;" "codeine" is given as "cadine;" "electrode" as "electroid," along with other printer's errors too many to point out.

The author speaks of "naissant" hydrogen instead of nascent. He repeatedly uses the French word "melange"—not italicised—in place of the English "mixture." He speaks of a "cannella" colour instead of "cinnamon" colour." He tells us that a certain alkaloid has been obtained "from the putrefaction of the cephalopode pulps (*sic*) common to the shore of the Mediterranean." "Poulpe" is a name applied in French to certain cuttles, squids, &c., but it is not English either in its original form or when modified into "pulp."

We regret to see a valuable and useful book thus disfigured, and we hope that a second edition when it appears may be freed from the many typographical errors and the Gallicisms which occur in that before us.

Qualitative Chemical Analysis. By Dr. C. Remigius Fresenius, Director of the Chemical Laboratory at Wiesbaden. Tenth Edition. Translated from the Fifteenth German Edition, and Edited by C. E. Groves, F.R.S. London: J. and A. Churchill.

The work of Dr. Fresenius has passed through so many editions, and has earned such general approbation, that to describe its scope and its characteristic features would be utterly superfluous.

The editor informs us, in his Preface, that care has been taken to keep closely to the original text, and there have been none of those attempts at abridgment which marred a former English edition. Additions have been made to that portion of the work which relates to the organic bases and the systematic procedures for their detection. The artificial alkaloids, such as aniline and the animal bases,—ptomaines and leucomaines,—do not come within the plan of the work. It might, perhaps, be thought that the so-called rare earths should have been considered at greater length. But their reactions, and even the elementary character of some among them, are by no means as yet fully ascertained.

The Appendix contains the toxicological methods of Stas, of Dragendorff, Sonnenschein, Graham, and Hofmann, and the dialytic method of separation.

The Index is very copious, and, as far as we have been able to test it, correct.

Any recommendations of a work like this might justly be censured as attempts to "gild refined gold."

Prof. A. E. Foote will lecture on "Gems and Ornamental Stones of the United States," at the Trophy Room, American Exhibition, on Saturday next, October 22nd, at 6 p.m. The chair will be taken by Mr. F. W. Rudler, President of the Geologists' Association.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 13, September 26, 1887.

Distillation of Citric Acid with Glycerin.—Ph. de Clermont and P. Chautard.—The sole product of the reaction is pyruvine.

Velocity of the Oxidation of Solutions of Organic Substances by Potassium Permanganate.—M. Dreyfus.—The author gives his results in the form of a table, the relative velocities of oxidation ranging from 0·20 for saccharose, to pyrogallol, 10000·00.

No. 14, October 3, 1887.

General Results of a New Study of Several Series of Fatty and Aromatic Amines.—M. Malbot.—These new researches lead to a general interpretation of the formation of amines. The final products result from a conflict of energies between the rival affinities of ammonia and the amines for the ether present and for its acid. The growing complication of the amines is the result of a series of successive transformations. The constitution of the amines has been explained on two theories, that of ethylene and that of ethyle, Hofmann preferring the latter, M. Berthelot and the author inclining to the former.

Colours derived from the Aniline Chromates.—S. Grawitz.—The author contends that his aniline black differs from that of Lightfoot and Lauth by containing combined chromium.

General Acidimetric Process for Wines, Musts, Ciders, Beers, &c.—M. Tony-Garcin.—The author uses a normal solution of caustic soda. As it is dropped in the wine turns to a violet-black, more and more dirty, which at last is turned by a single drop to a brown-black without the slightest violet or green tint. This is the exact point of saturation.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., May, 1887.

Some Notes on the Assay of Silks.—Jules Persoz.—In this paper the author discusses the methods proposed for estimating the matter fraudulently added to silks under the name of weighting, loading, or charging. These methods he shows to be deficient in accuracy. H. Sainte Claire-Deville proposed, some years ago, to calculate the proportion of genuine silk present from a determination of the nitrogen, as silk contains 18 per cent of nitrogen, whilst the substances used in its falsification are non-nitrogenous. The author moistens the silk in hydrochloric acid and dries in a stove at 120°. The acid is first diluted with two or three volumes of water, and the sample, after being steeped for a few moments, is exposed to the air before being taken to the stove. It can then be reduced to an impalpable powder, which can be uniformly mixed with the soda-lime. [It is probable that the trade will endeavour, by means which it is not our place to point out, to introduce extraneous nitrogen into the weighted silks—which would of course render this method untrustworthy]. For the detection of tin, which is now introduced even in undyed silks, M. Persoz places in a test-tube a small quantity of the silk in question, and heats it for a few moments with strong hydrochloric acid added in quantity just sufficient to effect a complete solution. The liquid is diluted with water, filtered if turbid, and treated with a current of sulphuretted hydrogen; if tin is present, even in very slight quantities, there is formed a precipitate of the yellow sulphide easily recognised. Tussah silk may easily be distinguished from

mulberry silk by the following reaction:—It does not dissolve in boiling zinc chloride unless this reagent marks at least 60° B., whilst mulberry silk disappears very rapidly in the same reagent at 45° B. In case of a mixture of the two silks, zinc chloride at 45° B. will dissolve the mulberry silk after boiling for a minute, leaving the tussah silk unattacked.

Report on Auramine.—Prof. C. Graebe.—Auramine belongs to the group of colouring-matters prepared latterly by means of tetra-methyl-diamido-benzophenone. This latter body is a product of the reaction of carbon oxychloride upon dimethylaniline (phosgene gas). In 1883 Dr. Kern prepared, for the first time, on a commercial scale, carbon oxychloride, and produced tetra-methyl-diamido-benzophenone, and a colouring-matter known as crystal violet. On a further study of tetra-methyl-diamido-benzophenone, Kern and Caro obtained auramine, a yellow colouring-matter which can be mixed with other basic colouring-matters, capable of being fixed upon cotton by means of tannin.

Action of Hypochlorous Anhydride upon Iodine Trichloride.—H. Basset and Fielding.—From the CHEMICAL NEWS.

Non-acid Components of Bees' Wax.—Fr. Schwalb.—From the CHEMICAL NEWS and *Liebig's Annalen*.

Flame for the Spectrum.—G. Fielding.—From the CHEMICAL NEWS.

Lecture on the Colours of Metals and Alloys.—Prof. W. Chandler Roberts-Austen.—From *Nature*.

New Method of Assaying Quinine Sulphate with Reference to the Alkaloids which Generally Accompany it.—O. Schlickum.—The author finds that not merely quinine but also cinchonine form chromates which at common temperatures require about 2000 parts of water for solution. In a solution of 0·01 grm. quinine or cinchonine sulphate in 20 c.c. of water, potassium chromate does not produce a precipitate. Quinidine and cinchonidine chromates are much more soluble in water. A solution of quinine chromate saturated in the cold is not precipitated by caustic alkalies, quinine hydrate having about the same degree of solubility as quinine chromate. If we, therefore, precipitate a solution of quinine sulphate by potassium chromate, and await the complete crystallisation of the quinine chromate, which requires at least four hours, the filtrate is not rendered turbid on adding caustic soda if the quinine sulphate is pure. On the contrary, if it contains cinchonidine, quinidine, or cinchonine there is formed an opaque flocky turbidity. Cinchonine dissolves only in 4000 parts of water, whilst its chromate dissolves in 2000 parts; consequently caustic soda renders a saturated solution of cinchonine chromate turbid. Chromates of quinidine and cinchonidine dissolve in about 400 parts of water. The bases themselves are much less soluble. The author's method of assay is as follows:—In a test-tube boil 0·5 grm. quinine sulphate with 10 c.c. of distilled water; then add 0·15 grm. of potassium chromate (neutral) in powder. Shake up carefully and set aside for four hours, stirring from time to time, and pour upon a filter. If the quinine sulphate is pure the filtrate will not be rendered turbid either immediately or in the course of an hour by the addition of a drop of caustic lye at 36 to 40° B. If one-half per cent of cinchonine sulphate or one per cent quinidine or cinchonidine sulphate is present the liquid, after the addition of caustic soda, will become turbid in less than an hour.—(*Chemiker Zeitung*, *Pharm. Zeitung*, and *Pharm. Central-Halle*).

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 11, June 5, 1887.

(The bulk of the articles in this number have appeared, in substance if not in form, in the *Comptes Rendus*, and have been duly noticed).

Displacement of Ammonia by Magnesia.—Berthelot and André.

Thermic Researches on the Reactions between Ammonia and the Magnesium Salts.—Berthelot.

Contributions to the History of the Decomposition of Amides by Water and Dilute Acids.—Berthelot and André.

The Nitrogenous Principles of Vegetable Soil.—Berthelot and André.

Researches on the Tension of Dry Ammonium Dicarbonate.—Berthelot and André.

Decomposition of Ammonium Dicarbonate by Water, and on the Diffusion of its Components through the Atmosphere.—Berthelot and André.

Researches on the Phosphates.—Berthelot.

On Ammonium-Magnesium Phosphate.—Berthelot.

Combustion and Formation-Heats of Solid Hydrocarbons.—Berthelot and Vieille.

Combustion and Formation-Heats of the Sugars, the Carbohydrates, and Kindred Polyatomic Alcohols.—Berthelot and Vieille.

On Terpinol.—Bouchardat and Voiry.—The authors find that there exists in terpinol an inactive monohydrated terpilene, for which they propose the name of inactive terpilenol or terpol. This inactive terpilenol forms about five-sixths of the entire mass of the terpinol.

Reply to the Remarks of L. Naudin on a Note relating to M. Roussan's Process for the Purification of Phlegmes.—M. l'Abbé Godefroy.—Already noticed.

Reply to M. Kupferschlæger.—F. Weil.—A discussion on Weil's process for the valuation of zinc-powder.

New Process for Preparing Neutral Lead Chromate in Crystals.—L. Bourgeois.—The author boils precipitated lead chromate with nitric acid diluted with five to six volumes of water, decants, and filters the hot solution over glass-wool. It deposits crystals on slowly cooling.

On Glyceric Aldehyd.—E. Grimaux.—This memoir is not adapted for useful abstraction.

Identity of the Cyanaceto-acetic Ether of Mr. W. James with Aceto-cyanacetic Ether.—A. Hallier and A. Held.—The nature of this communication appears sufficiently from the title.

Decomposition of Sodium Sulpharseniate by Silver Nitrate.—Ch. Preis and Bohuslaw Rayman.—Already noticed.

Action of Arsenious Acid upon the Chlorides of Acids.—Bohuslaw Rayman.—In the present paper the author studies the action of benzoyl chloride upon arsenious anhydride at moderate temperatures.

Contributions to the History of Cholesterine.—Bohuslaw Rayman.—The author has not succeeded in preparing either sodium cholesterate nor its ether.

The Chemical Laboratory of Wiesbaden.—The chemical laboratory of Geh. Hofrath Prof. Dr. R. Fresenius, at Wiesbaden, enjoys a very large attendance. In the summer term (1887) there were 77 students on the books. Of these 51 were from Germany, 8 from Austria, 4 from England, 3 from Russia, 3 from North America, 2 from Sweden, 2 from Spain, 1 from Holland, 1 from Belgium, 1 from France, and 1 from Brazil. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged, as teachers in the establishment, Prof. Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. (Med.) F. Hueppe, and Architect Brahm. The assistants in the instruction laboratory were two in number, in the private laboratory sixteen, and in the Versuchsstation three. Besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory and the Versuchs-station, on behalf of manufacture, trade, mining, agriculture, and hygiene.

THE CHEMICAL NEWS.

Vol. LVI. No. 1457.

THE RELATION OF SCIENCE TO THE STATE.

VI.

We have summarised the principal causes which in Britain prevent capable men from turning their attention to scientific research. We have pointed out that the interference of Government, in as far as it exists, is unfavourable, by establishing and upholding the examinational system of education, with its corollaries, payment by results and cram. On this system the condemnatory utterances of scientific authorities are far more numerous than we have space to enumerate. In addition to the evidence already given we will merely quote the following declaration by Prof. Huxley:—"If it should so happen that a Claude Bernard or a Ludwig should turn up in London among you gentlemen, at the present time, I really do not know what we should do with him; I do not think we could turn him to account. I think we should have to export him to Germany or France."

Such is Prof. Huxley's deliberate opinion as to the uncongenial atmosphere which original research encounters in the United Kingdom!

Another manner in which Government Departments contrive to discourage original research is in filling up scientific appointments. Such posts are but few, and there is the greater urgency that they should be bestowed upon men who have proved themselves competent to enlarge the existing scope of human knowledge in their special departments. But no such necessity is recognised. Judging from official documents such appointments are made by "open competitive examination." In the regulations issued there is neither inducement nor reward for research. We might reasonably expect that, in the selection of professors, demonstrators, curators, &c., original observations, or experimental results might be considered of paramount moment, and if of exceptional value might decide the contest irrespective of all other considerations. But not so; investigations however successful, discoveries however brilliant, count here absolutely for nothing; their very possibility is not taken into account, and their production by any candidate would, we fear, be looked on as something very like contempt of court.

It may not be regarded as beside the question if we quote from one of these official papers: it refers, indeed, to the appointment as Assistant in the Natural History Department of a certain Museum, but in its spirit it may serve as a general specimen. Candidates were first to submit themselves to a "preliminary" scrutiny in handwriting, orthography, arithmetic, English composition, and translation from Latin, French, and German. If satisfactory in all these subjects he proceeds to the main competition. The "obligatory" section of this ordeal comprises, in any case, elementary mathematics (in which 500 marks are obtainable), and any two of the seven following subjects: inorganic chemistry, 500 marks; organic chemistry, 250; physics, 750; zoology (in which the candidate must pass), 500; botany, 500; geology and mineralogy, 500; physiology, 500; and drawing, 500."

This programme is unsatisfactory, in as far as it awards more possible marks for physics than for zoology, which is to be the life-business of the successful candidate.

But, as if on purpose to swamp the meritorious specialist, there is superadded an "optional" department, to which, with inimitable logic, more marks are awarded than to the obligatory. This optional department comprises any of the above seven subjects which the candidate has not selected as obligatory, and in addition any of the following:—"Higher mathematics, 1000 (!!); theoretical mechanics, 500; applied mechanics, 500; French, 500; German, 500; Latin, 400; Greek, 400; and English History, 400."

Under such regulations a biologist "pure, simple," a specialist who has concentrated his attention and devoted his time to the study of the organic world, could stand a very slender chance of success, especially if pitted against a mere smatterer in biology who happened to be well versed in physics, mathematics, and languages. If such regulations are at all a fair average sample of the manner in which public scientific appointments have to be obtained, it is no wonder that we, as a nation, make so poor a figure in original investigation.

Returning to the instance we have just quoted, we may ask how many of the world's greatest naturalists would escape being ignominiously "plucked" in competition with rivals possessing an excellent verbal memory and accustomed to the "cramming" process. Eminent men of Science admit that they would utterly fail if examined on their own published researches against men of such a stamp. How often must the public be reminded that what we want in professors, curators, &c., is not *receptivity*—the only thing which can be fairly tested by any examination—but the power of origination. The question is not what a man knows, but what he can do.

Our present method of requiring irrelevant qualifications not only wastes time, but renders the student liable to acquire habits of thought foreign to his destination. If he has to distinguish nicely between peculiarities of form, of texture, of colour, or odour, he will not be greatly aided by having to turn his attention to words and abstractions.

Not very long ago we felt much pain on finding that, according to a recent ukase, the ranks of surgeon-major and brigade-surgeon are in future to be conferred by examination, not by *rebus gestis*,—*i.e.*, the appeal to past professional success. Here, again, memory will carry the day in opposition to tact, to suggestiveness, and mental resources.

It will, we think, be now plain that by various arrangements Government interferes *against* scientific research. We may entertain doubts as to the policy of the direct patronage of Science by endowments and subventions, and emeritus chairs attached to Universities; but there is surely little room for doubt as to the necessity for a cessation of the hostile interference to which Science and scientific men have been hitherto subject. Our inferiority to Germany cannot be essentially rectified without legislative action; but such action will not, or at least need not, involve heavy demands upon the public purse. How this may be effected we shall endeavour to show in our next issue.

ON SOLUTION.

By SPENCER UMFREVILLE PICKERING.

A short time ago I had occasion to call attention to the danger of attempting to draw conclusions from thermochemical data which are imperfectly understood, as exemplified by a "fundamental law" discovered by Mr. C. A. Seyler, the supposed discovery of which was due to the author having travelled round a circle and arrived at the same point from which he started, without becoming aware of the fact (Chemical News, lv., 227). I have again to call attention to a precisely similar performance which appeared in the Chemical News, (vol. lvi., p. 152). The article is one by Mr. W. Durham "On Solution," being a paper read before Section B of the British Association: in this the author (whose views on solution coincide with my own in many respects), says "that the heat of solution *varies directly*—

(1) As the heat of combination of the positive ele ments of the salt with O in water varies.

(2) As the heat of combination of the negative element of the salt with H varies. And *inversely*—

(3) As the heat of combination of the positive and negative elements of the salt varies."

The first example given of this is—

$$\underset{A}{Mg,Cl_2} - \underset{B^*}{Mg,O,Aq} - (\underset{A'}{Ca,Cl_2} - \underset{B'}{Ca,O,Aq}) =$$

$$= \underset{D}{MgCl_2,Aq} - \underset{D'}{CaCl_2,Aq},$$

D and D' representing the heat of dissolution of the solid chlorides, the other quantities representing the heat of formation of the compounds from their elements in the various states in which they exist at ordinary temperatures. (N.B. *Not* the heat of combination of the constituent atoms, quantities which are unfortunately unknown, and which alone would serve for conclusions such as Durham draws).

Now the value of Mg,O,Aq is derived from the equations—

$$R = Mg,2O,2H,Aq - 2H_2,O$$

and—

$$Mg,2O,2H,Aq = Mg,O,Aq + H_2,O,$$

in which R represents the heat evolved when solid magnesium is dissolved in water.† (See Thomsen, "Thermochem.," iii., 225), whence—

$$Mg,O,Aq = R + H_2,O,$$

similarly Mg,Cl_2, is deduced from the equations—

$$Mg,2O,2H,Aq + 2(Cl,H,Aq) + N = Mg,Cl_2,Aq + 2H_2,O,$$

and—

$$Mg,Cl_2 = Mg,Cl_2,Aq - MgCl_2,Aq,$$

in which N is the heat of neutralisation of the alkali with hydrochloric acid: from these two equations—

$$Mg,Cl_2 = 2(H,Cl,Aq) + R + N + MgCl_2,Aq.$$

Similarly with the calcium compounds: whence Durham's equation becomes—

$$[2(H,Cl,Aq) + \underset{A}{R} + N + MgCl_2,Aq] - [\underset{B}{R} + H_2,O] -$$

$$- [2(H,Cl,Aq] + \underset{A'}{R'} + N' + CaCl_2,Aq] - [\underset{B'}{R'} + H_2,O] =$$

$$= \underset{D}{MgCl_2,Aq} - [\underset{D'}{CaCl_2,Aq}];$$

and since the heat of neutralisation is independent of the nature of the base, N = N', and then all the quantities cancel, leaving—

$$MgCl_2,Aq - CaCl_2,Aq = MgCl_2,Aq - CaCl_2,Aq,$$

a result which is not surprising, and which is entirely independent of the magnitude of any of the quantities concerned. Whatever be the value of the heat of dissolution of the salts, or the formation of the salt molecules, his equations must hold good, for the calculation if the latter quantity involves the former.

I have already pointed out that this must be so (*Chem. Soc. Trans.*, 1887, p. 599), and is in reality one of the many consequences of the heat of neutralisation being independent (in ordinary cases) of the nature of the base. Thus another form of expressing Durham's equation would be—

$$\underset{A+D}{Mg,Cl_2,Aq} - \underset{B}{Mg,O,Aq} = \underset{A'+D'}{Ca,Cl_2,Aq} - \underset{B'}{Ca,O,Aq},$$

which would simply be a concrete example of "the general fact that, the heat of neutralisation being independent of the nature of the base, it follows that the heat of formation in solution of the same salt of two different metals differs by a constant quantity independent of the nature of the salt, . . . this difference being simply that existing between the reactions of the two metals with water."

The second equation given by Durham is—

$$Na,Cl - H,Cl,Aq - [Na,Br - H,Br,Aq] = = NaCl,Aq - NaBr,Aq,$$

which is still more obviously a truism than his first; for Na,Cl is calculated from—

$$Na,Cl = R + H,Cl,Aq + N + Na,Cl,Aq,$$

and hence by expanding we get—

$$R + H,Cl,Aq + N + NaCl,Aq - H,Cl,Aq - [R + H,Br,Aq + N + NaBr,Aq - H,Br,Aq] = NaCl,Aq - NaBr,Aq,$$

or O = O.

The other instances given are of a precisely similar nature, and need no further comment.

I may perhaps be allowed to add one word of advice, which, if attended to, would save some who are seeking for general laws in thermo-chemistry from pursuing such *ignes fatui*. If the theoretical and experimental numbers agree absolutely, the theory is certainly false; if they agree within 100 cals., the theory is probably false; whereas if the theory is valid, a variable error of several hundred calories will certainly exist. A very slight practical acquaintance with thermo-chemistry would teach that errors of this magnitude must exist in all quantities which are calculated, as in the instances discussed above, from several different experimental results. On the other hand, a certain amount of non-concordance must not be taken as proof that the theoriser is not arguing in a circle, for such non-concordance is often produced by thermo-chemists (Thomsen in particular) taking different values in calculating various data,—taking average or mean values in one case, and special values in another.

* I fail to see why the heat of formation of the oxides in the presence of water—*i.e.*, *plus* their heats of dissolution—should be compared with that of the chlorides in the *solid* state.

† With magnesium the value of this reaction is really deduced from that observed when the metal is dissolved in hydrochloric acid. Putting it in this form simplifies the equation by rendering it more general without otherwise affecting it. (See Pickering, *Chem. Soc. Trans.*, 1887, p. 600.)

DEEP SEA DREDGINGS: EXAMINATION OF SEA BOTTOMS.

By THOMAS T. P. BRUCE WARREN.

In my previous communication on this subject I omitted to refer to Professor Ehrenberg, of Berlin, who has so thoroughly identified himself with this department of research. I believe Prof. Ehrenberg was one of the first to examine, microscopically, deep sea dredgings, some of which were undertaken for the Atlantic Cable Expedition, 1857.

I propose to deal with the bottoms brought up from Tropical waters of the Atlantic, a few years ago, during certain telegraph cable operations. These soundings were made for survey purposes, and not for any biological or chemical investigation; still I think that this imperfect record may be a useful contribution to chemical science bearing especially on marine operations.

Although there is little to be added to the chemistry of this subject, still I think there are few chemists who could successfully make an analysis of a deep sea "bottom" without some sacrifice of time and patience, to say nothing of the risk of wasting a valuable specimen.

The muds, clays, oozes, &c., from deep water are so very fine that they pass readily through the best kinds of filters, and it is necessary to wash out all traces of sea-water as a preliminary. The specimen must be repeatedly washed by decantation, until the washings are perfectly free from chlorine, when the whole may be thrown unto a filter *merely* to drain; the turbid water which passes through is allowed to stand so that the suspended matter may settle, and, after decanting the clear supernatant water, the residuum is again thrown unto the filter.

The washing and getting ready for the drying oven will, in some cases, require days to carry out, if we wish to avoid losing anything.

So far the proceeding is exactly the same, except

draining on a filter, which would be adopted for preparing for the microscope. On no account should the opportunity be missed of mounting several slides, permanently for microscopic examination. Drawings or photographic enlargements will render us independent of direct microscopic appeal, which is not at all times convenient.

The substance, if drained and allowed to dry on the filter, will adhere most tenaciously to it, so that it is better to complete the drying in a porcelain or platinum capsule, either by swilling the filter with a jet of water or by carefully removing with a spatula. The most strenuous care must he used not to contaminate the specimen with loose fibres from the filter.

The perfectly dried matter is best treated in exactly the same way as a residuum in water analysis. It is a common thing to ignite the residuum, and to put the loss down, if any, to water. This ought not to satisfy an accurate observer, since organic matter, carbonates,—especially in presence of silica,—will easily add to the loss. The best plan is to heat a small portion very cautiously, and note if any smell or alteration in colour, due to carbon, &c., is perceptible, and to proceed accordingly.

I have seen some very satisfactory analyses made on board ship by a skilful use of the blowpipe, where liquid reagents would be very inconvenient to employ.

It will be necessary to say a few words as to the way in which soundings are made at sea. When the bottom consists of sand, mud, or other loose matter, it is easy enough to bring specimens to the surface, and, of course, we know in such a case that the bottom has been reached, but, in the event of the bottom being hard and rocky, it is not easy to say that our sounding has been successful: and here we meet with a difficulty which unfortunately is most unsatisfactorily provided for.

The lead is "cast," as the saying goes, "armed" for this emergency. An iron sinker is made with a hollow recess in the bottom: this is filled in with tallow, and on striking the bottom any loose matter may adhere by being pressed into the tallow. If the bottom is rocky or hard we get simply an imprint in the arming, and when such a result is obtained the usual construction is "that the bottom is rocky" or hard.

Now this seems to me a point on which chemistry may give some very valuable help, for I am convinced that no sounding should be accepted unless evidence of the bottom itself is obtained. A few considerations will show that when we are working in very deep water, where there is a difficulty of knowing for certain that we have an "up and down" sounding, and the hardening of the "arming" by the cold and pressure, unless we bring up something we cannot be sure that we have touched the bottom: leaving the doubt on this point on one side, unless we use a very heavy sinker so as to get an indication of the released strain when it touches the bottom, we encounter another complication.

Sir William Thomson's sounding wire has added the element of reliability to our soundings in this latter case. The note given out by the wire when the bottom is reached is perceptibly different when under strain, even if the dynamometer should give an unreliable indication.

It has been found that when a "bottom" has been recovered by the arming with tallow, the adherent grease seriously detracts from the value of the specimen for scientific purposes. Washing with perfectly pure bisulphide carbon will save the sounding, but of course any living organism is destroyed. As we have plenty of contrivances for bringing up loose "bottoms" without arming, we have nothing to fear on this score.

There is a great difficulty to explain the vast accumulations of clay deposits on the ocean bed, and it has been suggested that some minute organisms may produce these deposits, as others give us carbonate of lime. Is there not a very great probability of some of the apparently insoluble rocky formations being answerable for these accumulations?

We must not forget the peculiar changes which such an apparently stable substance as felspar undergoes when disintegrated and exposed to the chemical action of sea-water. As these deposits contain both sodium and potassium our chemical operations must provide for the analytical result; in other respects the analysis can be proceeded with according to the operator's analytical knowledge.

I have seen some very good specimens of a soft bottom recovered by an ordinary "mushroom" anchor. Between Santa Cruz and Porto Rico we brought up a large quantity of globigerine mud from a depth of 1700 fathoms.

Anyone who has had to work on a rocky or coral bottom knows only too well how reliable an ordinary grapnel is in revealing the contour of the ocean or sea-bed.

Few operators are aware of the usefulness of an ordinary deep sea grapnel-rope, as used for cable work, in recovering specimens of the fauna of any locality. The grapnel-rope should be left down for a few months, so that the denizens of the deep may get used to it and make it their place of residence and *attachment*. The stench caused by their decomposition, unless the rope be kept in water, when hauled up will be in a few days intolerable, even to an individual with a sea-going stomach. I tried several chemical solutions for preserving specimens thus recovered, but nothing answered so well as the water itself drawn up from the same depth as the rope was recovered from.

Some interesting results may be obtained by washing a dredging by ordinary elutriation: in this way I discovered, by the presence of fragments of fresh-water shells, that we were working on the course of the drift from the Surinam River, although we were many miles northward of it. In the same way the drift from the Amazon can be recognised fully 150 miles to the north of that river. This is rather at variance with the course of a current setting out from Florida and striking the Brazilian coast: certainly its influence may not have been felt so near the coast, but an experiment fully confirmed the fact that a strong surface current was running in this direction.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

THE treatment of samples of iron ore naturally divides itself into two parts, the mechanical and the chemical, and it will be described under these heads. The care with which the identity of every sample was preserved throughout will be shown, and the methods, by which the determination of the different elements was rendered as accurate as the state of chemical knowledge would allow, will be given in detail.

THE MECHANICAL TREATMENT.

The sample was first taken from the bag and placed upon a large piece of clean strong paper, and the label was removed from the box and put in a little card-rack fixed over the bench. Half a dozen small chips, representing as nearly as possible the different varieties of the ore, were put aside and carefully labelled, to be used for specific gravity determinations, and for thin sections for the microscope.

The large steel mortar, Fig. 1, was half filled with the ore, the leather cover was adjusted, and the machinery

* From "Mining Industries of the United States."

was started. This mortar was cast at the Midvale Steel Works of Philadelphia, and was made of an exceptionally fine quality of propeller steel, containing over 1 per cent of carbon and about fifteen-thousandths of 1 per cent of phosphorus. The pestle was forged and hardened, and the wear, after crushing between 15,000 and 20,000 pounds of ore, was scarcely perceptible in either mortar or pestle. The mortar weighed about 70 pounds, and the pestle with the stem and weight about 25 pounds. The tappets, *a*, were faced with raw hide, which stood the wear of the cams, H, remarkably well, much better than either hard or soft iron or steel, the dust from the ore causing the latter to cut very fast. The shaft made about 90 revolutions per minute, and the ore, when the mortar was about half filled, fed itself, so that without any attention 25 pounds of hard ore in lumps was reduced almost to powder in about one and a half hours.

The stem, B, was hooked up so that the pestle cleared the top of the mortar, A. The pulley, D, raised the mortar clear of the block, and by means of the traveller, E, the mortar was emptied on the chilled iron plate, F, as figured in the sketch. The ore was ground to a fine powder on this chilled plate by the hardened steel muller, C, any of it falling off the plate being caught in the sheet iron troughs,

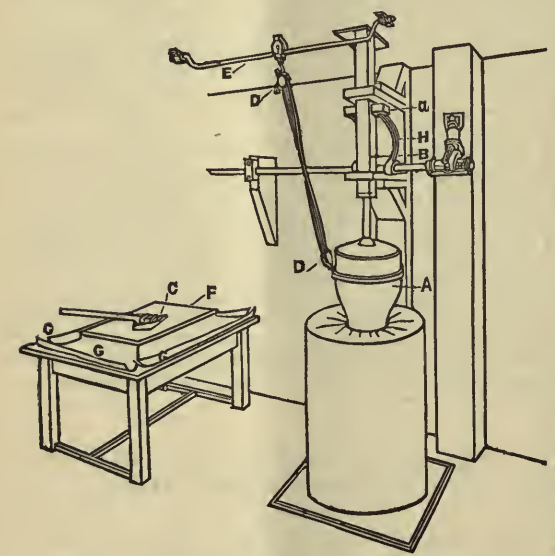


Fig. 1.—Chilled Plate and Steel Mortar.

G. It was thoroughly mixed and quartered, and the resulting sample, reduced finally to about 6 to 8 ounces, was placed in a clean dry bottle. This bottle had the number of the sample etched upon it, the same number, in figures half an inch high, pasted on the neck, and the label which came in the sample bag pasted on its side. The bottle was not taken into the grinding room until the sample was being ground, and was always previously numbered, so that when it was brought upstairs with the label the numbers could be compared and the label pasted on. A portion of the sample was ground in the agate mortar, A (Fig. 2), with an agate pestle, B, fitted in a flexible shaft, C, and revolving at the rate of 700 times a minute, transferred to a ground glass stoppered bottle, and dried at 100° C. It was then ready for analysis.

The Chemical Treatment.

Determination of Phosphoric Acid.

For ores low in phosphoric acid 10 grms. were dissolved in HCl, the solution was evaporated to dryness on the sand-bath, re-dissolved in dilute HCl (one part of acid to two of water), filtered, the filtrate treated with 10 c.c. NH_4HSO_3* to reduce the iron to the ferrous condition, NH_4HO added until the solution was nearly neutral, and then heated until it was decolourised. Five c.c. of strong HCl were added to decompose any excess of NH_4HSO_3, and the SO_2 driven off by passing CO_2 through the boiling solution. When the last trace of SO_2 was driven off, H_2S was passed through the boiling solution to precipitate any arsenic, the sulphide of arsenic filtered off, the beaker placed in cold water, and when thoroughly cooled, dilute NH_4HO added until a slight permanent green precipitate of ferrous hydrate remained after stirring. Acetic acid was added until this precipitate dissolved (a few drops should be sufficient), the solution diluted with hot water to about 800 or 900 c.c., and if the precipitate was white, a dilute solution of ferric chloride or bromine water was added until it became red. If it was necessary to add much ferric chloride, a few drops of ammonic acetate were also added to insure the decomposition of all the former salt. The solution was then heated to boiling, boiled a few minutes, filtered rapidly, and washed once with hot water. The filtrate should pass through the filter perfectly clear, and if the precipitate is red, any subsequent cloudiness of the filtrate is of no consequence. If, however, the filtrate passes the filter cloudy, it should

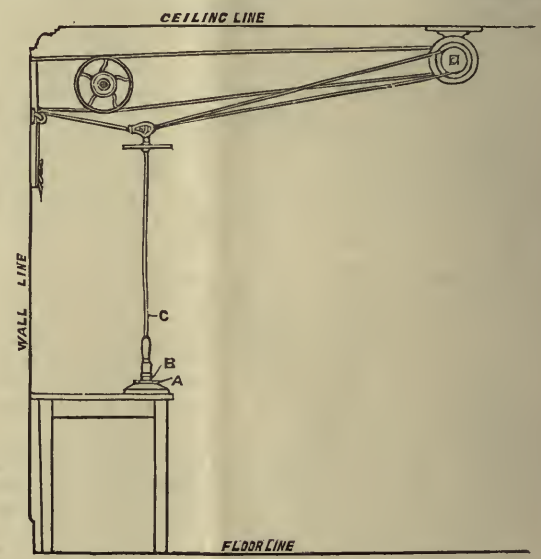


Fig. 2.—Agate Mortar with Flexible Shaft.

be returned to the main portion, a few drops more of ferric chloride added, and the solution again boiled and filtered. The precipitate of ferric phosphate, hydrate, and basic acetate was dissolved in hot dilute HCl (1—1) on the filter, and the large beaker cleared of any adhering precipitate with HCl; the whole solution and washings were received in a small beaker and evaporated nearly to dryness. Five to ten grms. of citric acid were dissolved in the least possible quantity of hot water, and filtered into a small beaker, into which were also filtered about 5 c.c. of magnesium mixture,† and the whole was added to the solution of the ferric phosphate. This solution was then neutralised by NH_4HO and cooled. When perfectly cold, from one-third to one-half its bulk of strong NH_4HO was added, and the solution was stirred

* Made by saturating NH_4HO with SO_2, generated by heating powdered charcoal and strong H_2SO_4 in a flask. The mixture was made of the consistency of cream, and the gas passed first through a wash-bottle containing water.

† Made by dissolving equal weights of $MgCl_2$ and NH_4Cl in the least possible quantity of water, filtering, adding $\frac{1}{4}$ bulk of NH_4HO, stirring occasionally and allowing it to stand for some days before using.

until the precipitate of $Mg_2(NH_4)_2P_2O_8$ began to form. After standing for some time, the solution was stirred again, and the stirring was repeated at intervals for an hour. It was allowed to settle over night, filtered on the asbestos felt in Dr. Gooch's pierced crucible, washed with dilute NH_4HO (1—3), dried on the pump, moistened with a drop or two of NH_4NO_3 in ammonia, dried and ignited until the glow passed over the precipitate, cooled in a desiccator and weighed as $Mg_2P_2O_7$. This precipitate was then dissolved in dilute hot HCl, the felt was washed on the pump, and the crucible was heated to redness and re-weighed. This weight, unless the precipitate of $Mg_2P_2O_7$ contained SiO_2, agreed perfectly with the original weight. In the latter case, however, the last weight of the crucible was subtracted from the weight of the crucible with the precipitate, to obtain the weight of $Mg_2P_2O_7$. The table A was used for calculating the percentage of P_2O_5, or P, instead of the factors 0·6396 or 0·2793.

Table for Phosphorus and Phosphoric Acid.

Mg.	P.	P_2O_5.	Mg.	P.	P_2O_5.
1	0·003	0·006	51	0·142	0·326
2	0·005	0·013	52	0·145	0·332
3	0·008	0·019	53	0·148	0·339
4	0·011	0·026	54	0·151	0·345
5	0·014	0·032	55	0·154	0·352
6	0·017	0·038	56	0·156	0·358
7	0·019	0·045	57	0·159	0·264
8	0·022	0·051	58	0·162	0·371
9	0·025	0·057	59	0·165	0·377
10	0·028	0·064	60	0.167	0·384
11	0·031	0·070	61	0·170	0·390
12	0·033	0·077	62	0·173	0·396
13	0·036	0·083	63	0·176	0·403
14	0·039	0·089	64	0·179	0·409
15	0·042	0·096	65	0·181	0·416
16	0·045	0·102	66	0·184	0·422
17	0·047	0·108	67	0·187	0·428
18	0·050	0·115	68	0·190	0·434
19	0·053	0·121	69	0·193	0·441
20	0·056	0·128	70	0·195	0·448
21	0·059	0·134	71	0·198	0·454
22	0·061	0·141	72	0·201	0·460
23	0·064	0·147	73	0·204	0·467
24	0·067	0·153	74	0·207	0·473
25	0·070	0·159	75	0·209	0·479
26	0·073	0·166	76	0·212	0·486
27	0·075	0·173	77	0·215	0·492
28	0·078	0·179	78	0·218	0·499
29	0·081	0·185	79	0·221	0·505
30	0·084	0·192	80	0·223	0·512
31	0·086	0·198	81	0·226	0·518
32	0·089	0·204	82	0·229	0·524
33	0·092	0·211	83	0·232	0·531
34	0·095	0·217	84	0·235	0·537
35	0·098	0·224	85	0·237	0·544
36	0·100	0·230	86	0·240	0·550
37	0·103	0·237	87	0·243	0·556
38	0·106	0·243	88	0·246	0·563
39	0·109	0·249	89	0·248	0·569
40	0·112	0·256	90	0·251	0·576
41	0·114	0·262	91	0·254	0·582
42	0·117	0·269	92	0·257	0·588
43	0·120	0·275	93	0·259	0·595
44	0·123	0·281	94	0·262	0·601
45	0·126	0·287	95	0·265	0·607
46	0·128	0·294	96	0·268	0·614
47	0·131	0·300	97	0·271	0·620
48	0·134	0 307	98	0·274	0·627
49	0·137	0·313	99	0·276	0·633
50	0·139	0·319	100	0·279	0·639

When the amount of $Mg_2(NH_4)_2P_2O_8$ was large it was dissolved, boiled, and re-precipitated, as a small amount of MgO was liable to be carried down mechanically with it. It was found necessary to avoid heating the $Mg_2P_2O_7$ after the glow had passed, as this salt is liable to attack the asbestos slightly at high temperatures, causing a small loss in weight of the felt on the subsequent solution of the precipitate in dilute HCl. For ores containing TiO_2 it was necessary to modify this process in several particulars. It was found that under certain circumstances phosphoric acid combined with TiO_2, forming a salt (possibly a phospho-titanate) very insoluble in HCl, so that in almost every instance phosphoric acid was found in the insoluble siliceous residue when this contained titanic acid. Also, upon neutralising the main solution, after adding NH_4HSO_3 in ores containing TiO_2, a fine white precipitate resembling $BaSO_4$ was formed, which usually remained after the subsequent addition of HCl, and was found to consist of TiO_2 with some P_2O_5. If, after dissolving the precipitate of ferric phosphate, &c.,

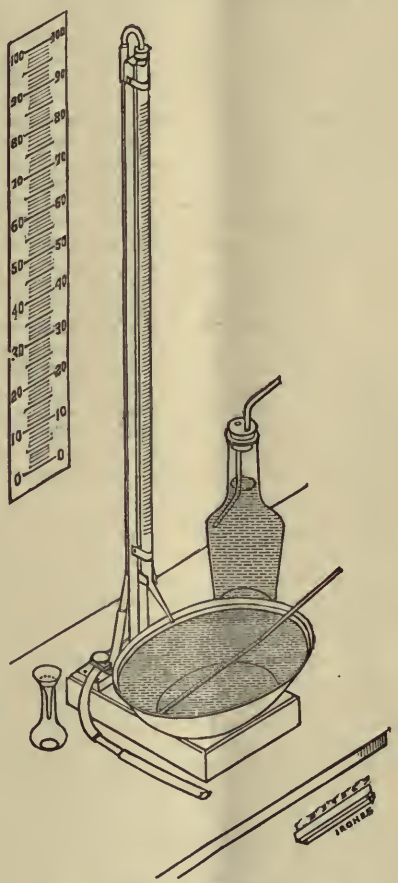


Fig. 3.—Burette.

thrown down by ammonic acetate, the solution was allowed to run to dryness, there was found after re-solution in HCl, a granular white or yellowish residue, absolutely insoluble in HCl, which consisted essentially of TiO_2 and P_2O_5. This reaction affords a very delicate test for TiO_2, for if the residue obtained in this latter case be collected on a small filter, dried, ignited, and fused with Na_2CO_3 and the fusion treated with hot water, a residue of $NaTiO_3$ will remain, which is insoluble in water. This residue, collected on a small filter, dissolved in a little hot dilute HCl and treated with Zn in a test-tube, gives the very characteristic violet colour due to Ti_2O_3.

When TiO_2 was found it was necessary to fuse the insoluble siliceous residue, the residue left in the filter from the solution of the precipitate by ammonic acetate,

and the residue left from the re-solution of this latter after it had run to dryness with Na_2CO_3. The fused mass was treated with hot water and filtered; the filtrate containing, besides silica and alumina and sodic carbonate, all the P_2O_5, while the TiO_2 remained on the filter as sodic titanate, insoluble in water. Potassium salts should not be used, as potassic titanate is decomposed by water. The filtrate was acidulated with HCl evaporated to dryness, dissolved in water with a little HCl, filtered, a few drops of solution of Fe_2Cl_6 added, and the ferric phosphate precipitated by ammonic acetate. This precipitate was filtered, washed, dissolved in HCl, and the P_2O_5 was determined by magnesium mixture as usual.

Sulphur and Iron.

One grm. of ore was fused with 10—12 grms. of Na_2CO_3 and a little KNO_3, the fused mass was run well up on the sides of the crucible, and the crucible was chilled. The mass was then detached from the crucible and transferred to a tall beaker, or the crucible with its contents was placed in the beaker and treated with boiling water. When the fused mass was entirely disintegrated (the crucible, if placed in the beaker, having been washed off and removed) the ferric oxide was allowed to settle. If the solution was coloured by alkaline manganate a few drops of alcohol were added and the solution was allowed to stand until the colour disappeared. If the solution after the disappearance of the colour due to the manganate was yellow, it was an indication of the presence of Cr_2O_3 in the ore. It was then decanted through a filter and washed twice with hot water by decantation.

The filter was washed once or twice with hot water, and the filtrate was acidulated with HCl evaporated to dryness, re-dissolved in hot water with a few drops of HCl, filtered from the SiO_2 and the sulphuric acid precipitated by $BaCl_2$ in the boiling filtrate. After standing over night in a warm place the $BaSO_3$ was filtered on the felt, washed thoroughly with hot water (and ammonic acetate, if it was large), and weighed as $BaSO_4$, which, multiplied by 0·1373, gave the S.

The crucible in which the fusion was made was treated with HCl, and when the adhering Fe_2O_3 was dissolved, a little hot water was added, and the whole was poured on the filter to dissolve any Fe_2O_3 which might have been in suspension in the solution of the fused mass. This was allowed to run into the beaker containing the Fe_2O_3, the crucible was rinsed, and the filter was washed with hot water. The whole was evaporated to dryness to render SiO_2 insoluble, re-dissolved in HCl, and transferred to a small flask of about 50 c.c. capacity. A small funnel was put in the neck of the flask and 3 grms. of granulated zinc in small lumps were added carefully to the solution. By heating the solution and adding a few drops of HCl from time to time, the ferric chloride was soon reduced to ferrous, which was shown by the solution becoming colourless. After washing down the neck of the flask and the funnel with a fine jet of water, if the addition of a few drops of HCl failed to impart any colour to the solution, the reduction was considered complete. Fifteen c.c. of dilute H_2SO_4 (1—1) were added, little by little, to the solution, and when the zinc had all dissolved, the neck of the flask and the funnel were carefully washed down and the flask was filled nearly to the top with hot water. The flask was then placed in cold water, and when the solution was thoroughly cooled it was washed out into an oblong white dish of about 1500 c.c. capacity and diluted to about one litre. A solution of permanganate of potassa was run in from a burette, the representation of which is given in Fig. 3.

This form of burette, the invention of Mr. Thomas H. Garrett, is the most satisfactory one I have ever used. The solution of permanganate was carefully standardised by means of ferric chloride of known strength, made by dissolving wrought-iron of known composition in HNO_3, driving off the nitric acid by repeated evaporations with HCl, diluting, filtering into a clean glass-stoppered bottle, and determining the Fe_2O_3 gravimetrically in a weighed amount of the solution. The strength of the ferric chloride solution being thus accurately known, a portion was weighed out into one of the little flasks previously mentioned, reduced with zinc, sulphuric acid added, and the strength of the permanganate solution determined by titration. The amount of the solution necessary to colour 3 grms. of zinc treated with HCl and H_2SO_4, and diluted to the same volume as the solution of the ore, was subtracted before calculating the value of the permanganate solution, and also from the amount of permanganate solution required for the ore before calculating the percentage of iron. By using H_2SO_4 in addition to the HCl, as described above, it was found that the end reaction with potassic permanganate was as sharp as if no HCl was used, and the results obtained were in all cases as accurate as could be desired. For many ores it was possible to dissolve the finely ground sample directly in the flask in HCl without previous fusion, but for those containing ferrous silicates, or pyrites, it was generally necessary to resort to fusion for the accurate determination of the total Fe.

(To be continued).

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN,

AND ON THE

CHEMICAL STRUCTURE OF THE TWO LATTER BODIES AND THEIR DISSOCIATION IN THE ATMOSPHERE OF THE SUN.

By Professor A. GRUENWALD.

DURING a mathematical investigation of the changes which the properties, and especially the spectra, of two gases undergo on their chemical union to a new substance, the author succeeded in finding a simple and important proposition of a future chemico-mathematical theory of perturbations, and by its means of discovering very remarkable relations between the spectra of hydrogen and oxygen on the one hand and of watery vapour on the other, as well as the chemically compound nature and the structure of hydrogen and oxygen, and in demonstrating the dissociation of hydrogen in the atmosphere of the sun.

I.

The above-named fundamental theorem is :—

"Let a be a primary chemical element which is combined chemically with other elements in a gaseous substance, A, and which in a unit volume of A occupies the volume $[a]$. Let A combine chemically with another gaseous body, B, to form a third, C. During this combination the element, a, passes into another chemical condition, a', giving off a certain quantity of heat (or otherwise taking it up) to render the new combination possible, and becoming, in consequence, chemically condensed (or expanded). Let the volume which it occupies in C, after the establishment of the new movable chemical equilibrium, be $[a']$, whereby the quotient $[a']:[a]$, according to a well-known fundamental chemical law, is a rational number, generally very simple. This being premised, the wave-lengths, λ, of all the rays belonging to the element, a, in the line-spectrum of the free substance, A (and are therefore emitted by it) are to the wave-lengths λ' of the corresponding rays, which the same element emits in its new chemical condition, a' (in which it exists in the now combined substance, A, within the newly formed combination, C), as the corresponding volumes $[a]$ and $[a']$."

This theorem holds good only when the substances in question are gases tolerably remote from the critical point of liquefaction, and existing not under too high a pressure. The modifications which it undergoes when

these conditions do not hold good, as well as the simple and natural fundamental suppositions upon which the proof rests, cannot be communicated except in an extensive treatise.

From the above theorem it follows especially that when $[a'] = [a]$, *i.e.*, when the volume of the element, *a*, in the new compound, C, is the same as in the original, A, the wave-lengths, λ', of the rays emitted by *a'* are equal to the wave-lengths, λ, formerly given out by *a*. The only difference will be in the different modification of the amplitudes, and therefore of the intensities of the single rays, when it may happen that the brightness of one entire series of rays may be enfeebled to vanishing, whilst that of another may be intensified. Thus, *e.g.*, the spectra of compounds formed without chemical condensation, such as of H with Cl, Br, and I, consist only of the spectra of H, on the one hand, and of Cl, Br, or I on the other, but with characteristic modifications of the intensity of the different rays of their components.

The limitation to the gaseous condition is necessary, since, as it is generally the case in chemistry, simple, regular, and easily intelligible regulations exist for gasiform bodies only. If the pressure increases, or if the gaseous substances approximate to liquefaction (whether by a reduction of temperature or a simultaneous increase of pressure) the number of collisions between two different molecules under otherwise equal conditions will be correspondingly increased, and the numbers of vibrations of the smallest equivalent particles of the different homogeneous molecules of the same substance are changed in different manners by different collisions. Whilst in the former case corresponding equivalent particles of different homogeneous molecules of the same substance emit extremely faint rays of equal wave-length which coincide in the spectrum, and by the summation of their individually very minute intensities, yield a single ray of perceptible brightness, in the case just mentioned the equivalent particle of different homogeneous molecules emit, along with rays of normal periods, also rays of more or less divergent periods, which owe their origin to heterogeneous collisions. Along with the normal line there fall now closely adjacent rays of the latter kind. The originally sharp line widens. If the pressure increases and if the gases approach liquefaction the widening of the line in question increases, and it may happen that the band produced extends into the region of lines which correspond to heterogeneous particles of the different molecules of the same substance. The lines of the spectrum flow together, and there is formed a more or less continuous spectrum, in which, perhaps, single luminous maxima betray the position of the former normal main rays.

II.

The most important of the remarkable relations between the line spectra of H, O, and of H_2O (in vapour) are :—

1. "All the wave-lengths of the second or so-called composite line spectrum of hydrogen, which have been determined in so excellent a manner by Dr. B. Hasselberg, of Pulkowa, and which owe their origin to a more complex structure of the H molecule, H', can, after elimination of the rays belonging to the elementary line spectrum, be converted into corresponding wave-lengths of the spectrum of water by multiplication with the factor $\frac{1}{2}$."

This proposition, which was first found out empirically (for a great number of rays) by comparing the second spectrum of hydrogen with the spectrum of water, as then known and then recognised as universally valid by means of the theorem (I.), is, according to I., a simple result of the circumstance that the modified hydrogen molecule, H', occupies in watery vapour exactly half its volume in the free condition. The knowledge of this put the author in possession of a great number of wave-lengths of the water spectrum hitherto unknown, *i.e.*, those which hydrogen produces under the influence of the oxygen in watery vapour. He was thus able, on May 9, 1887, to submit to Prof. G. D. Liveing, of Cambridge, an extensive list of wave-lengths of the water spectrum, hitherto unknown, for an experimental test of the accuracy of his chemico-mathematical theory of perturbation. These predictions, as it may be seen from the following list, have been very satisfactorily confirmed as far as Prof. Liveing's observations have hitherto extended, and especially for the rays $\lambda = 2800$ to 2607·8 and for $\lambda = 2603$ to 2449.

According to Prof. Liveing's letter of June 19 :—

Foretold.	Observed.	Foretold.	Observed.
2800·5	2799·8	2792·5	2793·8
2798·5	2797·6	2768·5	2768·3
2759	2759·7	2677·5	2677·3
2753	2753·1	2672	2671·1
2749	2748·2	2667·5	2668·2
2742	2742·7		2666·0
2731·5	2732·1	2660	2659·6
	2730·5	2652	2651·3
2718·5	2718·2	2646·5	2645·6
	2717·2	2642·5	2642·2
2713·5	2713·6		2640·4
2710	2709·5	2637·5	2638·5
2705·5	2706·2		2636·8
	2705·2	2633	2633·3
2699·5	2701·5	2629·5	2631·1
	2699·7	2623·5	2624·1
2693·5	2693·7		2623·3
	2693·2	2615·5	2614·9
2687	2687 6	2612	2611
	2687·2	2607·5	2608·3
2682·5	2683·5		
	2683·0		

According to letter June 26 :—

2603	2603·2	2516	2517·6
2599	2598·6		2515·1
2595·5	2596·4	2508·5	2509
2591	2591·3		2508
2585	2584·4	2491	2491·1
2578·5	2578·3	2487·5	2487·2
2572·5	2573·4	2484	2484·9
2564·5	2565·4		2483·7
2556	2556·4	2479	2479·3
2542	2542·7	2473·5	2474·5
2535	2536·6	2467·5	2467·1
	2534·1	2464·5	2464·5
2532·5	2531·4	2460·5	2460·0
2528	2529·2	2454·5	2454·7
2525	2524·2	2449	2449·3
2520·5	2521·7		
	2519·8		

The further rays which the author predicted on May 9, *i.e.*, from $\lambda = 2449$ down to $\lambda = 2207$ have not yet been determined with certainty owing to their extreme faintness. Below $\lambda = 2200$ Professors Liveing and Dewar have not yet succeeded in discovering any lines of the H_2O spectrum. Nevertheless, according to his theory, there must be a more refrangible section of the water spectrum of excessive faintness. The wave lengths of this section must correspond with the wave-lengths of hydrogen, as laid down by Dr. B. Hasselberg in an appendix to his researches on the hydrogen spectrum, in 1884.

The wave-lengths of the relatively somewhat brighter rays of this section of the water spectrum are :—2248·7 ; 2244·8 ; 2230·1 ; 2223·5 ; 2205·8 ; 2173·5 ; 2169·4 ; 2111·0 : 2110·8 ; 2105·9 ; 2102·2 ; 2099·6 ; 2097·5 ; 2090·8 ; 2089·7 ; 2088·2 ; 2087·2 ; 2085·3 ; 2078·0 ; 2038·7 ; 2034·6 ; 2033·2 ; 2031·0.

The experimental verification of this forecast can succeed only with a very peculiar arrangement of the procedures. Possibly the application of several sparks (or arcs) passing in series through moist gases, or through a broad stream of watery vapour, or better still of several hydrogen flames, similarly arranged in oxygen, and the observation of the rays emitted in the direction of their line of junction, might lead to the result desired. The rays

emanating from the more remote sparks or arcs would intensify the vibrations produced nearer at hand and taken up by the telescope. The author further proposes, according to the suggestion of his colleague, Prof. Zenger, to immerse the photographic plates before use in an extremely concentrated solution of chlorophyll, and then to dry them.

2. The wave-lengths of the elementary line spectrum of hydrogen may be divided into two groups (*a*) and (*b*), in such a manner that the wave-lengths of the one group (*a*) multiplied by the factor 0·6336 (very nearly 19-30ths) and those of the other group (*b*) multiplied by 4-5ths are converted into corresponding wave-lengths of the H_2O spectrum."

Hence it follows, with the aid of theorem (I.) that hydrogen consists of two primary elements, *a* and *b*, one of which, *a*, produces the group (*a*) under the influence of *b*, whilst the other, *b*, produces the group (*b*) under the influence of *a*. If (*a*) and (*b*) are respectively the volumes which the substances *a* and *b* occupy in a unit volume of hydrogen, then :— $[a]+[b]=1$, and according to (I.) $\frac{1}{2}\frac{9}{0}[a]+\frac{4}{5}[b]=\frac{3}{2}$; *i.e.*, $[a]:[b]=4:1$, $[a]=\frac{4}{5}[b]=\frac{1}{5}$.

Hence hydrogen is a compound of one volume of the primary substance, *b*, with four volumes of the other primary substance, *a* : H : *b* *a*4; it is, therefore, a compound analogous to ammonium NH_4, the volume of which, on its dissociation at a sufficiently elevated temperature, is in the proportion of 2 : 3.

The substance *a* is the lightest of all gaseous bodies, much lighter than hydrogen, and *b*, if we regard *a* as a univalent element, is a pentavalent gaseous element similar to nitrogen.

The line-spectra of the primary substances, *a* and *b*, can now, according to (I.), be easily calculated from the corresponding groups, (*a*) and (*b*), by multiplication with the factor $\frac{3}{2}$. Hereby, unfortunately, the errors in the wave-lengths of these groups increase in the same proportions. The star-spectra given by W. Huggins in *Phil. Trans.* (1880, vol. 171, Part II., p. 669 to 690), especially those of α Aquilæ and Arcturus, whose most refrangible rays are hydrogen rays, and according to 2 can be determined and corrected as hydrogen rays by comparison with the H_2O spectrum and with the solar spectrum, admit of a very fruitful completion of the H spectrum in its ultra-violet portion as at present known, and permit us to draw up a very copious spectrum of the primary element, *b*, The author prodeeds to give the spectra of the elements *a* and *b* of hydrogen, and places opposite to their lines. for comparison, the nearest lines of Frauenhofer and of the chromosphere.

The wave-lengths of the Frauenhofer lines were taken directly from a good copy of Angström's Atlas ; those of the chromosphere were obtained from Young's second list. The author reserves the right of resuming the calculations and comparisons as soon as he has access to Thollon's "Noveau dessin du spectre solaire," Piazzi Smyth's "Visual Solar Spectrum in 1884," and especially A. Rowland's "Photographic Map of the Solar Spectrum."

(To be continued).

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

SIR,—I observe in CHEMICAL NEWS, vol. lvi., p. 168, a letter from Mr. Thomas T. P. Bruce Warren, written in reply to that of mine published in the CHEMICAL NEWS, vol. lvi., p. 149.

Mr. Warren having asserted that "with a few trifling exceptions, all that appears from time to time in our chemical journals may be found in Chateau's *Corps Gras Industriels* (1864) and Fontenelle's *Manuel d'Huiles* (1866)," I gave a list of ten quantitative methods of examining oils, all or nearly all of which had "been devised or perfected within the last twenty years, and the majority of them within the last eight or ten, and hence could not have been described, or even foreshadowed, in books published in 1864 and 1866."

Mr. Warren now admits that he has "no practical acquaintance" with five of these general methods, viz. :— (1) Hausemann's method of titrating free fatty acids with the aid of phenolphthalein ; (3) Hehner's method of examining butter; (4) Reichert's method of determining volatile fatty acids ; (5) Gladding's process of separating fatty and resin acids ; (7) the improved methods of determining specific gravity devised by Bell, Estcourt, &c. Mr. Warren excepts, however, "a different reaction for the presence of free acids, and "the specific gravities of substances likely to contain air." But it is not a reaction for *detecting* free fatty acids, which was devised by Hausemann, but a process for determining their amount with the same facility and accuracy as a mineral acid admits of. If Mr. Warren has a still better method of effecting this, chemists will be glad to be informed of it. Similarly the improved methods of determining specific gravities of fats were not devised with the object of eliminating errors due to air-bubbles (though they may serve that purpose among others), and the reference made by Mr. Warren to this point suggests that he is not acquainted with their real object or character.

There remain five quantitative general methods of examining oils which Mr. Warren still maintains are contained or foreshadowed in Fontenelle's work, published in 1866. Fontenelle's work is not contained in the library of the Chemical Society, or any other to which I have access, and hence I am unable to refer to the pages quoted by Mr. Warren, and am under the necessity of asking him to quote the actual passages he relies on to prove his case.

Thus he contends that (2) Koettstorfer's method of ascertaining the saponification-equivalents of oils is "foreshadowed" on p. 19 of Fontenelle's work. But is any process of the kind described in a reasonably practicable form, and are figures given showing the behaviour of oils of different kinds when examined by the method ? If not, is it fair to assert that Koettstorfer's invaluable method was already known ?

Again, with respect to the method of determining the iodine-absorptions of oils recently devised by Baron Hübl, Mr. Warren states that the use of iodine is described in Chateau's work, published in 1864. Now, I challenge Mr. Warren to quote the passage on which he relies in support of this statement, and to quote the iodine absorptions given by Chateau for any six oils. It is evident that the *qualitative* use of iodine as a reagent for certain essential oils is quite another matter to its quantitative use for examining fixed oils in the manner devised by Hübl, and if Mr. Warren cannot adduce the evidence I demand, it is unfair to credit Chateau's work with a description of a method of determining the iodine-absorptions of oils.

As to Maumené's method with sulphuric acid, I simply claimed as new "the many quantitative determinations" made by his process, the publication of which Mr. Warren thinks unworthy of acknowledgment. If Mr. Warren would follow the example of other chemists, and publish the quantitative results he has obtained by his methods of determining free fatty acids and specific gravities, and the method of separating fatty substances from resins and rosin oils, described on page 415 of Fontenelle's book, he will earn the gratitude of many chemists who, like myself, were under the impression that the separation of fatty or resin acids was a difficult problem, which had only been solved comparatively recently; and who have also believed that resin and rosin oils were essentially different in their chemical nature, and could not be ex-

pected to behave analytically in the same manner. It has been said, I think in these pages, that nothing finds its proper level sooner than an analytical process. If this be true, it is curious that so many valuable methods as appear to be described in Fontenelle's book should not have found their way into more modern compilations.

Mr. Warren thinks the chemists who have devised improved methods of determining glycerin (9) deserve no recognition of their labours, since "the claim raised here ignores what we owe to Chevreul . . . . who indicated that the amount of glycerin from the same oil should be constant." I challenge Mr. Warren to show that Chevreul indicated any such thing; but if he did, is that any reason why Mr. Warren should deny any value to the more recently devised methods of *determining* glycerin? Mr. Warren seems to confuse the discovery of a chemical fact with the invention of an analytical process.

Mr. Warren states that he is "certainly not acquainted with a satisfactory mode of procedure" for determining "the higher alcohols in sperm and bottle-nose oils," and of hydrocarbon oils in fatty oils generally. Why then does he not publish figures showing the faulty nature of the methods on which chemists are accustomed to rely? But perhaps he has "no practical acquaintance" with these processes, any more than he has with Koettstorfer's, Reichert's, Hehner's, Gladding's, or Bell's methods. Until, however, he can claim this he is scarcely in a position to state that with a few trifling exceptions all of value about oils may be found in the antiquated works of Chateau and Fontenelle, or to state that we can hardly congratulate ourselves when we consider how little has been done during the last twenty years to render our knowledge of this very important subject more complete and trustworthy.—I am, &c.,

ALFRED H. ALLEN.

Sheffield, October 17, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 15, October 10, 1887.

Graduation of Tubes for Use in Gas-Analysis.—M. Berthelot.—The author fills the tube with mercury when in an upright position, the closed end being downwards, until it overflows, taking care that no air-bubble is interposed. A small flat piece of glass, rather thick, is pressed down upon the open end of the tube, which is then inverted. The whole—tube, mercury, and glass plate—is then weighed on a balance sensitive to 1 c.g. or beyond. When this is done the arrangement is taken out and placed above a small capsule, and one corner of the glass plate is raised slightly so as to permit a certain quantity of air to enter and a corresponding quantity of mercury to escape. The contact of the plate and the tube is re-established, the arrangement is laid on a large horizontal plane, and the graduation corresponding to a horizontal plane tangential to the surface of the meniscus is read off with a lens. He then weighs, as may be most convenient, either the mercury which has escaped into the capsule or the entire system formed by the tube, the mercury, and the plate which gives the weight of the mercury escaped by difference. This weight, divided by the exact density of mercury at the temperature of the experiment, furnishes with great precision the volume of the interior space now occupied by air and limited by the graduation. In this manner the graduation of any tube may be verified and a table of correction drawn up.

Action of Carbonic Acid upon Certain Alkaloids.—A. Ditte.—The author has obtained carbonates of some organic bases by placing in the tube of Cailletet's apparatus dry carbonic acid and a few drops of a liquid base. Crystalline compounds have thus been obtained of carbonic acid with aniline orthotoluidine and α-metaxylidine. The pyridic bases do not enter into combination with carbonic acid under these conditions.

A New Source of Capric Acid.—A. and P. Buisine. The authors use as a source suint waters, *i.e.*, water from washing wool, when it is about eight days old. They add to it a small excess of sulphuric acid and heat slightly so that the fatty matter may collect together. This is then washed repeatedly with cold water, purified by solution in ether, and the solution is filtered and distilled. From the crude fatty matter thus obtained pure caprie acid is extracted by a very circumstantial process.

The Direct Saccharification by Acids of the Starch contained in Vegetable Cellules. Extraction of the Glucose formed by Diffusion.—MM. Bondonneau and Foret.—The nature of this memoir appears sufficiently from its title.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., June, 1887.

Loss of Nitrogen by Plants during Germination and Growth.—W. O. Attwater and E. W. Rockwood.—From the *American Chemical Journal.*

Absorption of Atmospheric Nitrogen by Plants.—W. O. Attwater.—From the *American Chemical Journal.*

Valenta Method for the Assay of Oils.—George Hurst.—From the *Journal of the Society of Chemical Industry.*

Synthetic Formation of Closed Carbon Chains.—Dr. W. H. Perkin, Jun.—From the *Journal of the Chemical Society.*

Contribution to the Study of Rotatory Polarisation in Parallel Light.—Dr. G. Quesneville.—It results from this memoir that, independently of the complementary colours observed in the ordinary and extraordinary images of the analyser, there exists white light which accompanies, and may even mask, the colour of the images. In thin quartz plates the inequality of intensity of the two images being very great, the excess of the luminous intensity of one of these images over the other is due to white light. The intensity of the colouration increases with the thickness of the quartz, the intensity of the white light in each image tending to a uniform value. Arago's law of complementary colours is verified with plates of a certain thickness, but fails with thin plates, only one of the images appearing coloured, the colouration of the other being lost in the white light.

Industrial Society of Mulhouse.—Session of the Chemical Committee, March 9, 1887.

The Committee received a memoir by Max Becke on a new method of fixing chrome upon cotton. The principle of the method consists in reducing chromic acid by aniline in presence of the fibre. According to the proportions there is fixed an aniline grey and a certain proportion of chromic oxide. If the goods are then dyed in a colouring-matter which takes upon chromic oxide, we obtain very fast shades, resulting from the combination of the chrome lake and the aniline grey.

A sealed paper on a discharge process upon Congo reds, deposited by M. Casanovas, was opened at his request. He prints upon the red cloth, for a white discharge tin acetate, mixed with a small quantity of steam blue. Mixed with berry liquor, it gives a yellow, and with the further addition of steam blue an olive. With these colours may be associated a black with reduced logwood.

C. Kœchlin mentions to the committee the solubility of aniline in soap-lye. A lye containing 125 grms. of dry soap per litre dissolves about 100 grms. of aniline.

Chemical Nature of Vaseline.—C. Engler and M. Boehm (*Dingler's Journal*).—The authors have chiefly occupied themselves with natural vaseline, a product obtained by simple decolouration of petroleum or residues of petroleum with animal black, and then by elimination of the more volatile portions by distillation with superheated steam. The average composition of vaseline is given as 7·10 C : 14·83 H.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Rough Copper.—Can any of your readers inform me what quality of copper is understood by "rough copper," and also if the terms "rough copper" and matte are synonymous?—S. B. F.

MEETINGS FOR THE WEEK.

THURSDAY, Nov. 3rd.—Chemical, 8. "Note on the Atomic Weight of Gold," by Prof. Thorpe and A. P. Laurie. "The Interaction of Zinc and Sulphuric Acid," by M. M. Pattison Muir and R. H. Adie. "Note on Safety Taps," by W. A. Shenstone. "Note on Guthrie's Compound of Amylene with Nitric Peroxide," by Dr. A. K. Miller. "The Dehydration of Metallic Hydroxides by Heat, with special reference to the Polymerisation of the Oxides and to the Periodic Law," by Dr. Carnelley and Dr. J. Walker.

TO CORRESPONDENTS.

R. Romanis.—The diagram illustrating your article is too large to be usefully reproduced within the limits of the pages of this journal.

The LIST will OPEN TO-MORROW, SATURDAY, October 29th, and will Close on or before Thursday, November 3rd. Applications will be received by the National Provincial Bank of England (Limited), at all their branches, or by ordinary letter to the Secretary, enclosing deposit of 10s. per share.

CONDY'S WHITE LEAD COMPANY
(Limited). Capital, £200,000, in 40,000 shares of £5. First Issue of 20,000 shares at £5 each at par. Payable 10s. per share on application, £2 10s. per share on allotment, £1 per share three months after allotment.

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BANKERS.—The National Provincial Bank of England (Limited), 112, Bishopsgate Street, London, and all their branches.
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ABRIDGED PROSPECTUS.

This Company has been formed for the purpose of acquiring the patent rights and carrying on the business of white lead manufacturers, under Condy's patent, of which H. J. B. Condy and H. B. Condy, the well-known inventors of Condy's Fluid, are the vendors.

The ordinary method of manufacture occupies from four to five months—is most dangerous to the operatives, being attended with much suffering and even loss of life from the noxious vapours and poisonous exhalations and dust—requires considerable manipulation in its various processes, is somewhat uncertain in its operation, and the white lead produced is often more or less discoloured.

CONDY'S WHITE LEAD COMPANY
(Limited).

ADVANTAGES OF THE PROCESS.

The advantages claimed by Messrs. Condy's process may be shortly described as follows :—

1. White lead of the finest colour and body can be made within seven days, instead of four to five months, the time required by the ordinary process.

2. Any description of metallic lead may be used, including even old lead, all impurities being removed by Condy's process, whilst by the other it is necessary to buy a very good quality of lead, which is called in the trade "refined pig lead," and which has been almost entirely freed, at considerable expense, from all impurities. Old lead is about 8 per cent cheaper to buy than the refined lead.

3. The uncertainty in composition which white lead made by the old process is apt to sustain, is corrected by Condy's process, the composition being identical time after time, of the purest colour that can be made, with covering properties that have been found to excel any of the best known manufactures, and of the pure type described in the leading chemical works.

4. Condy's White Lead has been found to preserve its colour in impure atmosphere in preference to any other.

5. The considerable loss incurred under the ordinary process by droppings amongst the tan (estimated at about 5 per cent), and by the entire waste of the acetic acid employed, is completely avoided.

6. Absence of danger to the workpeople is ensured by the process, since nearly all the operations are effected by machinery, whereas by the ordinary mode of manufacture at every stage the white lead has to be handled.

The actual manufacture of white lead by this patented process has been carried on under Messrs. Condy's personal superintendence, at their works at Battersea for some time past, where they have been manufacturing and selling several tons a week (readily sold to the best colour grinders), with the object of proving on a commercial scale the practical nature of the process and the superior quality of the white lead produced, and the result clearly shows that the lead is produced at considerably under the cost of the ordinary process.

The Directors are advised that the working capital provided for by this issue will be amply sufficient to enable them to erect the necessary plant to manufacture about 100 tons per week, and that this output can be very considerably increased by a small additional outlay. Premises have been secured admirably adapted for this purpose, and are immediately available.

CONDY'S WHITE LEAD COMPANY
(Limited).

ESTIMATED DIVIDENDS.

Assuming that these 100 tons only be manufactured and sold per week, or less than one-tenth of the average weekly manufacture in the United Kingdom, it is estimated that this would realise an annual net profit of at least £20,000, equal to a dividend of 20 per cent on the present issue. This is independent entirely of any revenue from royalties, as to which it may fairly be expected that the Company ought to derive an additional profit by means of licences. This should produce profits amounting to a further dividend of from 15 to 20 per cent if only one-fifth of all the white lead manufactured in the country is made under this patent at a royalty of only 30s. or 40s. a ton.

The process is beyond the region of experiment and trial, and with the plant the Directors propose to erect this Company can immediately begin operations as manufacturers of an article proved to be readily saleable at remunerative prices.

It may also be added that Messrs. Condy have gained prize medals for their exhibits at ths only two Exhibitions at which they have exhibited their white lead—a gold medal at the Paris Exhibition, 1885, and a silver medal at the International Inventions Exhibition, London, 1885.

Full prospectuses and Forms of Application can be obtained of the Bankers, Brokers, and Solicitors; or at the Offices of the Company.

American Exhibition closes October 31st,

But, owing to the large number of orders now in, orders will be received and filled there till November 10th.

PROF. A. E. FOOTE of Philadelphia, would call attention to the short time remaining in which choice American Minerals can be had at low prices.

NEW ARRIVALS.—100 pounds of the beautiful Alaska Garnets, in mica schist. Nine boxes of other minerals from America, Germany, and elsewhere.

EDUCATIONAL COLLECTIONS on hand at the very low prices mentioned below. These collections have received the very highest commendations from nearly all leading educators in America. The following institutions have purchased here:—British Museum, Museum of Practical Geology (Jermyn Street), Science and Art Departments of London and Dublin, Cambridge University, &c.

Labels of £1 and higher-priced Collections give name, locality, and in most cases the composition, accompanied by Illustrated Catalogue. Sizes given are average.

NUMBER OF SPECIMENS ..	25	50	100	100	200	300
	In boxes			Without boxes.		
Crystals and fragments	2s.	4s.	8s.	4s.	8s.	12s.
Student's size, larger	6s.	12s.	24s.	£1	£2	£5
Amateur's size, 2¼in. × 1½ in.	—	—	—	£2	£5	£10
High School or Academy size, 2½ × 3½ in. Shelf Specimens				£5	£10	£20
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WHAT BETTER CHRISTMAS GIFT FOR A FRIEND?

SULPHUROUS ACID PLANT WANTED by Sugar Refiner, to produce One to Two Tons daily, 4 @ 6° T. —Address, Box 36, Royal Exchange, Glasgow.

Vitriol and Manure Works.—Foreman Wanted who thoroughly understands the manufacture of Vitriol and Manures, also Phosphate-grinding and the management of men. State age, experience, qualifications, salary expected, and what knowledge of machinery.—Address, Drogheda Chemical Manure Company, Drogheda.

THE CHEMICAL NEWS.

Vol. LVI. No. 1458.

THE RELATION OF SCIENCE TO THE STATE.

VII.

To point out an evil and to explain its causes are but unsatisfactory tasks unless we can indicate some method for its removal. Now unfortunately our national neglect of, or contempt for, scientific research has been too deeply ingrained into the public mind to be swept away by any statute; the three estates of the realm are powerless to silence either the purblind utilitarians who care only for immediate results or the blinder ethicists who are now becoming so rampant. But the feeling which these misleaders have generated may be gradually modified by a variety of methods.

In the first place it is necessary that, as far as the distribution of public honours are concerned, Science—pure Science—should be placed on an equality with Literature, and even with Law. This may seem a startling departure from our present practice; but to us it appears at once just and expedient. It is just, because if a man raises the reputation of his country throughout the civilised world, that country should, in return, do him honour. And in no way can the *prestige* of a nation be more signally enhanced than by its becoming a great focus of research and discovery. What does France, Germany, Russia know or care about our ennobled barristers or judges? What rank do these countries assign to them in comparison with a Faraday or a Darwin? Surely, then, we should not let it be seen that a man of transcendent ability, if he elects to devote himself to Science, must renounce all hopes of public appreciation at home and be content with the honours rendered him abroad.

Our next suggestion relates to a more limited sphere, as if carried out it could affect only men who have studied in our two ancient Universities. It is this: that the Fellowships of the Colleges in these Universities should be attainable by research alone, and should be tenable on the condition of continued research. We would not by any means claim that research in the natural and physical sciences should be the sole condition. Let literary and theological research have also their fair share, but let a certain proportion of these Fellowships be reserved solely as rewards for excellence in advancing chemistry, physics, biology, astronomy, &c. Let no amount of knowledge serve as a passport to these positions unless the candidate had proved himself able to make additions to the existing amount of human knowledge. In other words the applicant should prove himself to be not a mere well-filled bottle or cistern, of what capacity soever, but a flowing spring.

It may be news to some of our readers to be told that this proposal, far from being anything like a confiscation of property, is much more accordant with the intentions of the founders than is the present system. "The general public," says Mr. J. S. Cotton, of Queen's College, Oxford, "are not sufficiently acquainted with the truth that the present generation of Fellows, whether tutors or non-residents, are alike wrongful occupants of their comfortable positions, and usurpers when tried before the bar of history."

It would far exceed our limits were we to quote the statutes of the several Colleges in proof of our position. But whoever wishes for full evidence on the question need only consult a work entitled "Endowment of Research" (H. S. King and Co.). Here (pp. 38 to 51) he will find proof that "the Fellowship system originated in a desire to promote study, and not to promote teaching."

What a splendid revival of Science should we not witness if some twenty or thirty of the most promising minds in the country were, by the occupancy of these Fellowships, enabled to devote their whole time and energies to original research! This reform alone would go very far to remedy the evils of which we have been complaining. It may be said that the benefits of this arrangement would be limited to the graduates of Oxford and Cambridge. True; but is it too much to expect that when the national honour and benefit resulting from the labours of such a body of "researchers" became known, similar endowments would be founded in connection with our more modern universities?

But there are further inducements to original investigation which might be arranged without the necessity of any additional taxation, whether national or local. One of the simplest, though not the least efficacious, of these means would be the enactment that public scientific appointments, professorships, curatorships, the posts of assistants in laboratories, observatories, &c., should be attainable only by the production of original research, and not by "free competitive examination."

Similar should be the case with the highest University degrees, such as those of M.D., D.Sc., &c. Let these be attainable only by dint of original observation or experiment.

We are well aware that our proposals will be exceedingly unwelcome to the whole tribe of "coaches," "grinders," and examiners. If there is ever a prospect of their being carried out these worthies will shout, for longer than two hours, "Great is Cram, of the Britons." For all this we would beg all friends of Science calmly to consider the matter, and if they can suggest any more feasible method of promoting original research not to keep silence.

ON THE

THERMAL PHENOMENA OF NEUTRALISATION, AND THEIR BEARING ON THE NATURE OF SOLUTION.

By SPENCER U. PICKERING.

In my communication to the Chemical Society on this subject (*Trans.*, 1887, p. 593) I pointed out that the results proved that—

$$M,R,Aq - M',R,Aq = M,R',Aq - M',R',Aq,$$

and that "the only way, other than by mere chance, in which this equation might be produced, if the formation and dissolution of the salt were independent actions, would be if—

$$M,R - M',R = M,R' - M'R'$$

(the formation of the salt molecules), and—

$$MR,Aq - M'R,Aq = MR',Aq - M'R',Aq"$$

(the dissolution of the salt molecules), which view I dismissed as highly improbable and unsupported by any observed facts. In his communication to the Chemical News (vol. lvi., p. 162) Dr. Nicol, however, contends that such a view is not improbable. The experimental evidence which he brings forward in its favour is, that a few meagre experiments seem to show that the vapour pressures of salt solutions indicate a constant difference similar to that which he seeks to prove with respect to the true heat of dissolution of the salt, and that, as the vapour pressure is a direct measure of the attraction of the salt molecule on the water, a constant difference of a similar nature must exist between the true heat of dissolution of salts.

That further experiments should prove this law to hold good with respect to vapour pressures, I have no reason to doubt: it is what may be expected from the existence of similar relations observed in the case of the volumes of salts in solution, the lowering of the freezing-points, and

other physical data; but that the vapour pressures are a measure of the heat of dissolution is a pure assumption, and one for which we have no particle of evidence, and I trust before long to be able to show by experiment that such is not the case.

Even, however, if it should ever be found that the true heat of dissolution of salts conforms to the equation—

$$MR,Aq - M'R,Aq = MR',Aq - M'R',Aq,$$

and that, consequently, the heat of combination of the atoms to form the salt molecules conforms to the similar equation—

$$M,R - M',R = M,R' - M',R',$$

it appears to me that our reasons for regarding dissolution as a chemical action will be greatly strengthened thereby, for this would simply mean that the thermal phenomena of dissolution are of precisely the same character, and follow the same remarkable rule, as those of the combination of atoms in an undoubtedly chemical reaction.

It always seems to me that a great many of the points in dispute between Dr. Nicol and myself ought not in reality to exist, and that they arise through a persistent misunderstanding of each other's views.

Dr. Nicol's view of solution, as I understand it, is that the dissolution of a substance is not the result of chemical action, but of the forces of cohesion and adhesion; whereas my view is that chemical attraction is the principal, and in the generality of cases the only, cause of dissolution. So far we must agree to differ. But there are many facts which Dr. Nicol urges against this chemical, or hydrate, theory, which I think do not touch it in the least, and most of his conclusions from these facts I am perfectly ready to accept.

One great point which he strives to establish is that water of crystallisation (or, as I should prefer to express it, the same hydrate which exists in the solid state) does not exist in solution. But this does not affect the hydrate theory at all. The very essence of this theory—in its original form, at any rate—is that such a hydrate does *not* exist in solution, for a hydrated salt dissolves because it has a tendency to form a liquid hydrate, *higher* than that known in the solid state.

Then, again, another point of attack made by Dr. Nicol is that *all* the water present bears the same relation to the salt. This also may well be the case, even according to the hydrate theory. Taking a concrete instance as an illustration — $CuSO_4$ dissolved in 100 H_2O—two views may be taken of the action on the hydrate theory:—

(1) Some hydrate higher than that known in the solid state—say $CuSO_4,15H_2O$—is formed, and mixes with the rest of the water. This is the commonly accepted view.

(2) The hydrate which is formed by the salt and water is of a more complicated, and therefore more unstable, nature, being a hydrate of a hydrate (comparable with the multiple salts formed by the combination of double salts),—for instance, $(CuSO_4,7H_2O),20H_2O$,—and that this hydrate mixes with the rest of the water present. This is the modification of the hydrate theory which I have advocated (Chemical News, liv., 216).

But on either of these views the particular hydrate existing in the solution at any given moment depends on the relative proportion of salt and solvent, on the temperature, and on other conditions; and, above all things, (a point which Dr. Nicol seems persistently to overlook) these high and complicated hydrates are, as a mere consequence of their complexity, always more or less *dissociated*, and several of them—of a different degree of complexity, and dissociated to different extents—may therefore co-exist in the liquid at the same time. Now the result of this dissociation will be the same as in any other well-known case; the amount dissociated will depend on the relative proportions of its constituents present, and will be affected by the further addition of any one of them (say the water), probably even when the amount added is some hundredfold in excess of the actual amount required by the formula to form the hydrate present. It is, therefore, no argument against the hydrate theory to show that even the 400th H_2O added is affected by the presence of the salt.

But, further, all the water molecules present will *appear* to be in exactly the same condition. In a mass of dissociated hydrochloric acid we have the various units HCl, H, Cl, H_2, Cl_2. At any particular instant of time some of the atoms will be in a different condition from others; yet the gaseous mixture, when examined by most of our methods, appears perfectly uniform, because our experiments extend over a comparative long interval of time, and during that interval each atom of hydrogen and chlorine has been in each of the three possible states, for the same period, and hence they are indistinguishable from their fellows. Precisely the same must be the case of a partially dissociated hydrate in the presence of excess of water,—say $CuSO_4,15H_2O$ in presence of 85 H_2O; although at any given instant the various water molecules would be in a different condition one from the other, this would not be so if our experiments extended, as they do, over a considerable—instead of an infinitely small—period of time. It is true that in the second mentioned view of the hydrate theory, where the hydrate has the more complex constitution, $(CuSO_4,mH_2O)nH_2O$, although the nH_2O may thus be indistinguishable from the rest of the water present, there would be a difference between this and the more intimately (and possibly never dissociated) mH_2O. But the existence of such a difference, and the efficiency of our means of recognising such a difference, are totally different questions, and I maintain, as I have always done, that from the methods of investigation followed by Dr. Nicol it is almost hopeless to expect the detection of any differences which may exist between the combination of various water molecules, for these same methods fail, in most cases, to indicate even the far more intimate combination of the very radicles composing the salt molecules themselves.

DEEP SEA DREDGINGS: THERMOMETRY, TEMPERATURE, AND PRESSURE, DECAY.

By THOMAS T. P. BRUCE WARREN.

One of the most interesting subjects in physical science connected with deep sea survey is the matter of temperature.

The chemical changes which take place on the bed of the deep sea are only conjectural, still we have fair reasons for believing that the conditions at the bottom are not favourable to chemical action. We know that a low temperature will itself arrest changes in dead organic matter; added to this we have the antiseptic properties of salt water, but the influence of pressure we are unable to estimate.

There certainly ought to be no difficulty in closely imitating those conditions met with on the bed of the deep sea as regards temperature and pressure; we could then deal with some of those problems connected with biological science which seem at present unsolvable.

I remember, some years ago, experimenting on freshwater fishes, which were placed in water and submitted to a pressure of 150 lbs. per square inch. By extending these experiments, and providing for a suitable supply of air in the water, we could easily ascertain the depth at which any particular fish could live.

The statement made by Biot, that the air in the swimming-bladders of fishes was richer in oxygen in proportion to the depth in which they lived, is an interesting chemical and biological statement. Are deep sea fishes capable of decomposing water so as to account for this? Or are we to assume that the solubility of oxygen gas in water will explain this? In considering this point we

must not lose sight of the agitation, with the increased facilities of solution which the ocean waves produce. How are we to account for the changes and structural development of sea plants, which are chained by their habits of growth beyond the reach of atmospherical oxygen, unless we assume the medium o solution or aqueous decomposition?

We have some interesting records of the temperature at great depths, by the *Challenger*. Before seeing these readings I met with a curious result in the West Indies, on the average temperature between Cienfeugos and Santiago (Cuba). The copper resistance of a submarine cable laid between these two places showed a mean temperature of 26° F. Portions of this cable were laid in water near and at the landing-places which had a temperature of 80° F., so that we know the main portion must have been laid in water colder than 26° F.

H.M.S. *Druid* reported "No bottom at 2800 fathoms" in the route of submergence. The low temperatures recorded by the *Challenger* in deep water, near Bermuda, confirm my belief that the cable in question must have been laid in water, for some of its length, much below the freezing-point of fresh water. A moderate allowance, based on the principle of approximate differences, will make the lowest temperature 23° F.

A thermometer was designed by Sir William Thomson, I believe, in which the mercury on contracting was followed by a column of liquid which left a stain or mark of its downward track. This thermometer may have given doubtful indications, but still the idea was so simple and feasible that we regret not hearing more about it.

I am not aware that anyone has given a satisfactory explanation for such low temperatures as we find at the bottom of deep water.

We know that in deep water the temperature falls as we go lower down; absence of solar influence and non-circulation are generally regarded as the principal or entire cause. I am unable to endorse this opinion, still I am willing to allow that they may exert some influence.

From some experiments which I made in 1862 I found that pressure alone is capable of reducing the temperature of water. A pressure of 25,000 lbs. per sq. inch was found to lower the temperature fully 20° F. in a short time, the initial temperature being 60° F., which was reduced to 40° F. A jet of water issuing from the cylinder showed this reduction of temperature, so that evidently it was permanently lowered to 40° F. This result alone may have made one pause before accepting it as fact. Fortunately a coil of insulated wire was being experimented on at this time, and the reduction in its copper resistance, when kept there for some hours, corroborated the same fall of temperature.

The pressure produced by a column of water is taken as being proportional to the depth. Now the lowering of temperature does not follow quite so simple a proportion as this, but is expressed by a function compounded of the depth and the temperature of the superincumbent water.

From these considerations it is evident that the readings of an ordinary mercurial thermometer in deep water will have a double source of error, viz., the contraction due to pressure, and the contraction of this contraction due to reduced temperature.

I have tested the electrical resistance of copper wire under various temperatures and pressures, and I have not met with a single case in which pressure exerts the slightest influence. The experiments were made under pressure as high as 50,000 lbs. per square inch. On the contrary, knowing the resistance at any unkown temperature, there is no difficulty in finding the temperature provided the initial resistance has been carefully measured at some known temperature.

I constructed a thermometer for observing deep sea temperatures by changes of resistance, but having to leave England before it was completed I was not able to use it for deep sea purposes. The accuracy of the instrument and its suitability for getting temperatures at inaccessible depths were verified by experiments in deep wells.

A small coil of copper wire, insulated with silk, was made by winding on a metal bobbin (one layer only being made); over this a brass case carefully fitted, and the intervening space was filled in with mercury. The copper was well varnished, to prevent any action of the mercury. The coil was lowered by a cable containing three separate and well-insulated wires, each having the same wire, so that their resistances, compared with each other, were identical. Two of these insulated wires were connected to one end of the coil, and the third wire to the other end of the coil.

As we have to provide for the varying temperature through the depth to the coil itself, we first measure the resistance through the double lead: one of these leads only is used when testing the coil, so that we eliminate the resistance of the leads and get that of the coil only. When the resistance shows no variation after five or ten minutes, we know that the coil has the same temperature as the water surrounding it.

The coil is lowered still further, and another observation taken. This lowering and testing is renewed, and, when the log line paid out for two successive observations is followed by the same resistance, we may fairly infer that the first result showed that we had reached the bottom. The cable itself is the log line, and measures the depth at which our temperature observations are made.

I am not aware that anyone has *proved* that chemical action is arrested in deep water; it is generally assumed that decay does not take place. A very interesting fact, worth placing on record, is that the decay of india-rubber, due to catalytic action, is decidedly arrested: this is, no doubt, due principally to the reduction of temperature, for the decay proceeds rapidly in the warmth.

Although I am aware that the decay of india-rubber is attributed to oxidation, I must say that it is, in my opinion—which is confirmed by experimental observation—a secondary action only.

A NEW METHOD FOR DECOMPOSING ARSENICAL SULPHIDES.

By H. WARREN, Research Analyst.

The following is an outline of a new method of decomposing cobalt speiss, or arsenical alloys of the same:—The regulus to be decomposed is first broken into pieces, about 1 lb. in weight, and suspended by means of oiled string, or other suitable support, in a vessel containing crude hydrochloric acid, to which has been added about 1 oz. of copper nitrate, and the whole allowed to remain for the course of a day or so to undergo dissolution, the copper nitrate reacting with the hydrochloric acid present, forming cupric chloride, while the nitric acid evolved reacts on the metals composing the regulus to form nitrates of the same, which in their turn are again decomposed, generating by so doing sufficient nitric acid to react on a further portion of undecomposed regulus.

The alloy by this treatment is deprived largely of its nickel and cobalt, besides other metals present, such as arsenic and bismuth, which have passed into solution, while the remaining portion having become sufficiently brittle to be readily reduced to a powder, but still containing notable quantities of both nickel and cobalt, is calcined at a low red heat in a plentiful supply of air, by which treatment the residue—consisting of arsenides and sulphides—are wholly converted into arseniates and sulphates, which are readily brought into solution by means of crude hydrochloric acid, and added to the original solution. Metallic iron, in the form of bars, is now brought into contact with the solution, by which means the whole of the copper present is removed as

metallic copper, together with a considerable quantity of the arsenic and bismuth present, the iron passing into solution as chloride, which is again separated by the addition of milk of lime, carrying with it the remainder of the arsenic as basic arseniate of iron. The remaining salts of nickel and cobalt still existing in solution are precipitated together by means of sodium carbonate, as carbonate of nickel and cobalt; they are next disseminated through water, and chlorine gas passed through until saturation, the whole of the nickel by this means passing into solution, the cobalt remaining precipitated. The solution containing the nickel is brought to a state of ebullition, in order to free it from the excess of chlorine present; the nickel precipitated as hydrate, by means of caustic soda, ignited to expel the water present, and reduced to the metallic state by the usual method. It has been found preferable, for various reasons, to separate the calcium salts present, by means of dilute sulphuric acid, before proceeding to separate the nickel and cobalt.

ON THE ANALYSIS OF ALUM CAKE.

By ROWLAND WILLIAMS, F.C.S.

Some months ago an inquiry appeared in the Chemical News with reference to the most accurate method of analysis of alum cake, more especially as regards the estimation of alumina and free sulphuric acid. Having for the last two years devoted a considerable amount of attention to analyses of this description, my experience of the subject may perhaps be of some interest.

In making a complete analysis of alum cake, a large representative quantity of the sample—say 400 grains—should be weighed in a beaker, dissolved in pure water, the solution passed through a weighed filter, and the latter thoroughly washed, dried, and weighed. The insoluble matter may be ignited and examined further, if necessary.

The filtrate is made up to 10,000 grains with pure water. Formerly I took 1000 grains of this solution, = 40 grains of the sample, for the estimation of the alumina and other bases. This was placed in a porcelain basin, boiled with a few drops of nitric acid, and precipitated with slight excess of ammonia, all the usual precautions being observed in the precipitation and washing, so as to ensure the purity of the alumina. Even when working with every possible care, I have, however, generally obtained results somewhat above the truth.

The precipitate contains the alumina and any iron which may have been present, whilst most of the lime, magnesia, potash, and soda will be found in the filtrate. These may be estimated by the usual well-known methods. The iron is best determined volumetrically in another portion of the original solution, and subtracted from the total precipitate with ammonia.

The reason why the alumina generally comes out too high is, I believe, owing to the co-precipitation of a little basic sulphate of alumina, which is very difficult to thoroughly decompose, even by intense ignition over the blowpipe. On this account I have recently adopted the "hyposulphite" method for the precipitation of alumina, as it is easily carried out and gives accurate results. The alumina precipitated by this method is much easier to wash than when thrown down in the usual gelatinous form, and the hyposulphite process also possesses the advantage of separating the alumina from any iron which may have been present in the solution.

The estimation is performed by placing an aliquot portion of the original solution of alum cake in a porcelain dish, neutralising, if necessary, with a few drops of sodium carbonate solution, adding a considerable amount of sodium hyposulphite, and boiling for some time. The precipitate is then filtered off, well washed, dried, and ignited in the usual manner. A certain amount of free sulphur is precipitated along with the alumina, but is, of course, expelled during the ignition.

The iron, lime, and magnesia may be estimated in the filtrate from the alumina, after decomposing the excess of hyposulphite with hydrochloric acid. In complete analyses of alum cakes I now usually make an estimation of the alumina by both methods, as the potash and soda, if present, cannot be determined in the filtrate from the hyposulphite.

The *total sulphuric acid* is best estimated gravimetrically, taking every possible precaution to ensure the purity of the barium sulphate.

With regard to the determination of the *free sulphuric acid* the method most frequently employed is, I believe, the one depending upon extraction with strong alcohol. The process is usually carried out by taking 300 or 400 grains of the sample (if that quantity be available), and digesting all night in a stoppered bottle with strong alcohol. The alcohol (which is assumed to extract the whole of the free acid, but practically nothing else) is then passed through a dry filter, and the residue washed several times with small quantities of strong alcohol. Some operators dilute the alcoholic filtrate with water, and evaporate off the alcohol before titrating with soda. This is not only unnecessary, but causes actual loss of acid by its action on the alcohol when heated. I simply add a drop or two of phenol-phthalein solution to the alcoholic filtrate, and titrate directly with seminormal or decinormal caustic soda.

In order to ascertain the amount of loss which occurs on evaporating off the alcohol, the following experiment was recently made in my laboratory:—Two equal quantities of the sample were taken, and treated with equal volumes of alcohol in the manner above described. One filtrate was titrated with soda directly; the other after evaporating off the alcohol. The following was the result:—

	With evaporation.	Without evaporation.
Free sulphuric acid	0·35 per cent.	0·44 per cent.

In the experiment under consideration, therefore, about one-tenth of a per cent of acid was lost by evaporation with alcohol.

It is necessary that the digestion of the alum cake with alcohol should proceed for several hours, preferably all night, as I have found that contact with alcohol for a short time,—say an hour,—even with frequent agitation, fails to extract the whole of the free acid. In one experiment which I made, bearing on this point, equal quantities of alum cake were digested with strong alcohol for one hour, four hours, and twelve hours. The result was as follows:—

	1 hour.	4 hours.	12 hours.
Free sulphuric acid	0·29 p. c.	0·36 p. c.	0·42 p. c.

As the alcohol process is somewhat tedious when a number of samples are being examined, I have repeatedly endeavoured to devise a shorter method for the estimation of free sulphuric acid in alum cakes and other aluminous compounds. For a long time I confined my attention more particularly to the reaction with Congo red, which is immediately changed to a blue by acid, but is unaffected by solutions of alumina when certain precautions are observed. I hoped to be able to make this reaction the basis for a colorimetric process, but after a considerable amount of work in this direction I have been obliged to abandon the idea, as the results obtained were so unsatisfactory.

My latest experiments have been made with various alkaloids, especially quinine, morphine, and strychnine. These would, presumably, combine with the free sulphuric acid to form sulphates of the respective alkaloids. In order to form the neutral sulphates of the three above-mentioned alkaloids, the following percentages of sulphuric acid are required:—

Morphine.	Quinine.	Strychnine.
17·19 per cent.	30·24 per cent.	14·67 per cent.

The plan which I found to answer best, and therefore adopted, was to add 1000 grains measure of a perfectly clear 10 per cent solution of alum cake to very accurately weighed quantities of quinine, strychnine, and morphine contained in small beakers. After standing a short time, with frequent stirring, the liquids were passed through weighed filters, the undissolved alkaloids thoroughly washed with cold water, dried, and weighed. In this way the amount of alkaloid soluble in 100 grains of the sample was ascertained, and from the figures just given the percentage of sulphuric acid was easily calculated. In making these calculations the solubility of the various alkaloids in pure aluminous solutions was disregarded, and the whole of the dissolved alkaloid was assumed to have combined with the free acid. This will probably account for the estimations invariably giving higher figures than the ordinary alcohol extraction method. I have tried what may be called the "alkaloid" process on several samples of alum cake and sulphate of alumina, and have found the percentage of free sulphuric acid from one-tenth to one-eighth of a per cent higher than those indicated by the "alcohol" method. I append the results of a sample of alum cake recently examined by these methods:—

Free Sulphuric Acid.

Alcohol.	Strychnine.	Quinine.	Morphine.
0·41 p. cent.	0·54 p. cent.	0·50 p. cent.	0·51 p. cent.

It will be seen that all the alkaloids gave somewhat higher figures than the usual method by extraction with alcohol. Probably the latter method will still continue to be preferred, as I believe, on the whole, it yields the most accurate results; but the "alkaloid" process will also be found useful as a check in any doubtful case.

Chemical Laboratory, 9, Albert Square, Manchester,
October 24, 1887.

IMAGE TRANSFERENCE.

By M. CAREY LEA, Philadelphia.

By the term Image Transference I propose to denote certain effects produced on sensitive films, effects curious in themselves, and of interest in connection with the subjects of papers which have recently appeared in this journal.

In those investigations it was shown to be possible to take a film of a silver haloid—chloride, bromide, or iodide, and after making marks upon it with sodium hypophosphite, to obtain a development of these marks, precisely as if they had been impressed by light, but quite independently of any exposure to light. I now propose to show that it is possible to develop on a film of silver haloid a complete image — a print from a negative for example, without either exposing the silver haloid to light, or to the action of hypophosphite, or subjecting it to any treatment whatever, between the moment of its formation and that of its development. The film of silver haloid comes into existence with the image already impressed upon it.

For this purpose almost any silver salt is selected; citrate, benzoate, tartrate, pyrophosphate, &c., answer perfectly. (Some silver salts, the phosphate especially, undergo a slight reduction spontaneously in the dark; these are less suitable). A film of the silver salt selected is formed on paper by the ordinary methods, and this is exposed under the negative to a few seconds of sunshine.

The next step is to convert this film into one of silver chloride or bromide, by plunging it for a few minutes into dilute acid. Ordinary hydrochloric acid may be diluted with six times commercial hydrobromic with two or three times its bulk of water; the exact strength is unimportant. After a short immersion the acid is to be washed out, and it only remains to put the film, now consisting of silver haloid, into a ferro-oxalate developer, when the image appears at once. The chloride or bromide of silver into which the salts above mentioned are rapidly converted by the halogen acid, comes into existence with the image already impressed on it at the instant of its formation.

So that although the substance which received the image is completely broken up and destroyed, the image is not, but is transferred in all its details to the new film of silver haloid.

It is therefore evident that the action of light on all silver salts that can thus transfer an image must be similar in all its essentials to the action of light on the silver haloids. An important conclusion follows, that all such silver salts must be capable of forming sub-salts, else the image could not be transferred. In the case of most silver salts the existence of such sub-salts has not before been recognised, or even suspected; indeed, if I am not mistaken, the existence of such a sub-salt of silver phosphate has been expressly denied. But the image formed by light on silver phosphate can be transferred, therefore sub-phosphate must exist.

These results have also a very direct bearing on the subject of one of my previous papers (CHEM. NEWS, vol. lvi., p. 77. I there endeavoured to show that the photo-salts of silver, as obtained by purely chemical means, are identical with the products of the action of light on the silver haloids, both with the material of the latent image and with the visible product of the continued action of light, or rather with the most characteristic constituent of that product. As respects this latter identity, I showed that although the brightly coloured photo-chloride could not be obtained by the direct action of light on silver chloride, it could readily be formed indirectly by acting with light on other salts of silver, and treating the product with HCl.

It might be argued that in this proof one link was wanting, viz.:—Proof that the photochloride obtained by the action of HCl on silver salts, other than chloride, exposed to light, was of the same nature as that obtained by the action of light directly on silver chloride. The results above described supply that link, if it was needed, and show that the photochloride obtained by the action of HCl on silver salts, other than the chloride, exposed to light, has the same capacity for development as has the material of the latent image obtained on ordinary silver chloride.

But this proof itself may be thought liable to an objection. It may be said that as an image was certainly impressed upon the original film, it is not completely proved that the halogen acid had anything to do with the ultimate production of a developed image. The objection would not be well taken, and the experiment may be varied to two ways, either of which eliminates it.

Most silver salts are soluble in nitric acid. After applying the halogen acid it may be washed off, and the paper may be placed in nitric acid until every trace of the original salt (supposing that any escaped the action of the HCl or HBr) is removed, and until it is absolutely certain that nothing is left in the film but the silver haloid. When this is done, the development, so far from being impeded, is rendered only the stronger and brighter. Certainly, therefore, the silver haloid is the essential base of the development.

Another very decisive experiment may be made in this way. Paper prepared with tartrate, oxalate, or almost any other salt of silver, is to be exposed for a minute or thereabouts to a strong light (not under a negative). It is then taken into a dark room, and marks are made upon it either with a glass rod or a camel's hair pencil dipped in dilute hydrochloric or hydrobromic acid. After letting the acid act for five or ten minutes, it is to be washed off, the paper plunged into nitric acid, and after again washing it can be placed in a developing solution, when the marks made will appear black on a white ground. This mode of operating gives a very convincing result. The nitric

acid treatment may be omitted, but when this is done the number of salts that can be used is more limited. The four salts first above mentioned give good results, even without the nitric treatment, but some silver salts undergo a spontaneous change in the dark by keeping a short time, such that when they are placed in a developing solution (without exposure to light) they may blacken instantly all over. Silver tartrate is one of the best salts to operate with, though pyrophosphate, citrate, oxalate, and some others do almost equally well. Sulphate, antimoniotartrate, phosphate, nitrite, and arsenite do not give good results, except with the nitric acid treatment.

With a salt like tartrate or oxalate the experiment is very striking. The paper imbued with it is exposed to light over its whole surface, it is then taken into the dark room, and simply marked with dilute HCl or HBr and washed. Thrown into a developer, all the marks of the halogen acid quickly blacken, proving, first, that the effect of light is transferred from the one salt to the other; second, that the effect as transferred to the chloride or bromide is far more susceptible of development than it was in the original salt. It seems a not unreasonable explanation of this last mentioned fact that the greater sensitiveness of the haloid compounds may depend on their power to combine with their own sub-salts, so that the reduction may commence with the sub-salt, and quickly extend from it to the portion of normal salt with which it is combined; that, on the other hand, other silver salts may not share this power of uniting with their sub-salts, and are consequently more slowly and imperfectly attacked by the developing solution. This explanation may or may not be correct, but seems not improbable.

A curious fact incidentally presented itself in the course of this investigation; that when paper prepared with silver salts, other than the haloids, was exposed to light, and then marked with HCl, the effect of a short exposure, so far as development was concerned, was as great as that of a long one. A piece of paper was prepared with a given salt by non-actinic light. It was then placed between the leaves of a closed book with one end projecting. The book was then placed in the light (very faint sunshine), and the prepared paper was gradually drawn out, so that different portions received progressive exposures from 400 seconds down to 3 seconds. A number of marks were made with HCl diluted, parallel to the end of the paper, so that to each mark corresponded a different exposure from 3″ to 400″. The papers were then placed in nitric acid, washed, and developed. These pieces are before me as I write, and it is impossible to say by the appearances what portion received the 3 seconds, which the 400. The marks are equal in strength on each paper from one end to the other. The salts used were: silver benzoate, tungstate, phosphate, pyrophosphate, and tartrate. The short exposure gave a sufficient basis for development, the longer effected nothing more.

The object of this series of papers has been to offer a new explanation of the nature of the latent photographic image, and to show that it consists neither of the normal silver haloid physically modified, nor of a sub-salt, but of a combination of normal salt and sub-salt. That the sub-salt loses, in this way, its weak resistance to reagents, and acquires stability, thus corresponding to the great stability of the latent image, which, though a reduction-product, shows considerable resistance to even so powerful an oxidiser as nitric acid.

Further, that this combination of normal salt and sub-salts, which constitutes the material of the latent image, can be obtained by chemical means, and wholly without the aid of light. That the forms of these photo-salts, as I have ventured to name them, which correspond to the material of the latent image, are either colourless or nearly so, but that other forms, possessing beautiful and often intense colouration, also exist. With the chloride some of these brightly coloured forms show a ready tendency to reproduce colour, in some cases with well marked and beautiful tints. So that we have here an approach to the solution of the problem of obtaining images of objects in their natural colours from a quite new direction, and probably with better hopes of an eventual complete success than by any of the older methods.—*American Journal of Science*, vol. xxxiv., July, 1887.

GEMS AND ORNAMENTAL STONES OF THE UNITED STATES.

The Saturday Evening Lecture in the working men's cause was delivered, on October 22nd, by Prof. A. E. Foote, of Philadelphia, in the Trophy Hall of the American Exhibition on the above subject to the largest audience that has assembled during the season. The speaker was introduced with some very complimentary remarks by Mr. F. W. Rudler, Curator of the Museum of Practical Geology of Jermyn Street, and President of the Geologists' Association. One reason why so little is known about American gems and ornamental stones in Europe is that there is a ready market in America for everything of the gem character that is produced there. Thus far mining for gems has been of a very desultory character, being principally carried on in connection with mica and other mines, or by farmers and others when they have but little else to do. The emerald and hiddenite mines of North Carolina and the tourmaline mines of Maine are the only ones that have been worked systematically. Gems are the purest forms of minerals, and in nearly all cases are the result of crystalline action. If the conditions of crystallisation are perfect all impurities are excluded. Ruskin, in his "Ethics of the Dust," gives a charming illustration of this by supposing the power of crystallisation to be exerted upon the mud of a path of a manufacturing town. The gems peculiar to America are chlorastrolite, zonochlorite, and hiddenite. Chlorastrolite, or green star stone, is a species which was discovered by Prof. J. D. Whitney, of the United States Geological Survey, about forty years ago. The only place in the world where it is found is Isle Royale, Lake Superior. This island, belonging to the state of Michigan, forty miles long, five miles wide, and about twenty miles from the mainland is composed of amygdaloid trap, in the almond-shaped cavities of which the gem principally occurs. This green stone radiates from a centre and shows a beautiful chatoyance similar to cat's-eye, crocidilite, and other fibrous minerals. In 1868, when Instructor in Chemistry, &c., in the University of Michigan, Prof. Foote led a party from the University that camped for several months on the island.

For the first time the chlorastrolite was found in a vein stone associated with native copper and epidote. The best specimen ever found was secured by our party, and is now in Mr. Foote's possession. The second best one belongs to Mr. Morrison, of London, and the next best one, so far as the speaker knows, belongs to an American lady resident in London. About £300 worth are sold annually. Zonochlorite is a green banded stone similar to chlorastrolite in composition, but discovered by Prof. Foote at Nespigon Bay, on the north shore of Lake Superior. The full description was published in the *Transactions of the American Association for the Advancement of Science* in 1872. It is an entirely novel stone, hardness about 7, takes a very high polish, and if it could be found in sufficient quantities would undoubtedly be extensively used. used. Hiddenite is a green variety of the well-known species spodumene. A yellow variety from Brazil has been cut as a gem for many years. This variety has been known for about seven years, and is fully as beautiful and valued as highly as the diamond. It occurs in connection with emeralds in North Carolina. The locality is worked by a Stock Company, and produces about £500 worth of hiddenite and £600 worth of emeralds annually. One of the finest of these emeralds is in the British Museum.

The fullest series of them is in the collection of C. S. Bement, of Philadelphia. One weighs 8¾ ozs., within a quarter of an ounce of the weight of the most celebrated emerald in England. Of gold qnartz about £28,000 worth is sold annually. Most of this comes from California, where it is not only used as a gem, but in the manufacture of various ornaments. One of these, an imitation of the Cathedral Notre Dame, is valued at £4000. Prof. Foote saw no specimens in Hungary so good, though the gold penetrating amethystine quartz is very beautiful. Though Californian gold is worth about £3 10s. an ounce, nice specimens of quartz readily bring from £5 to £7 an ounce.

Although the flexible sandstone, the gangue of the diamond in Brazil, is found in mountain masses in North Carolina and other states no very large diamonds have as yet been discovered. Many small ones are recorded from California, North Carolina, Virginia, and elsewhere. The largest was found at Manchester, near Richmond, Virginia, weighed 23¾ carats in the rough and 11$\frac{1}{16}$ carats cut. It was valued, when found, at £800, and £1400 was loaned upon it later. Prof. Whitney states that the largest found in California was 7¼ carats. Rubies and sapphires have been found in the rock in the corundum mines of North Carolina, and C. S. Bement has an uncut green one in his collection that would give 80 to 100 carats worth of good stones, one of which would probably weigh 20 carats. This specimen is probably worth £200. The largest red and blue crystal weighs 312 lbs., and belongs to Amherst College. The best sapphires are found in the placer mines of Montana. Asteriated corundums are found in Pennsylvania and elsewhere.

About £2200 of quartz or rock crystals is mined annually. The best localities are Hot Springs, Arkansas, North Carolina, New York, and Virginia. A portion of a mass that must have weighed over 40 lbs. was recently received from Alaska, that cut a hand-glass three inches by five. They are frequently dug up in the pre-historic mounds, and were used by the medicine-men and others for foretelling future events. Amethysts are found in very fine specimens in Pennsylvania, Georgia, Texas, and the Lake Superior region. From the latter region they are very remarkably lined, some specimens showing "phantom crystals," equal to the Hungarian. Near the Yellowstone National Park and in the Chalcedony Forests of Arizona are tree-trunks, some of which are 100 feet long, turned to stone by the action of silicated waters. Some of these trees are still standing upright; others, having fallen, bridge deep chasms. The once hollow cavities of some are lined with amethyst, others with agate. The Arizona agatised or jasperised wood shows the most beautiful variety of colours of any petrified wood in the world, and auout £1500 worth is annually sold for ornamental purposes. Probably the most remarkable locality in the world for smoky quartz or cairngorm stone is Pike's Peak, Colorado. Here it is found, in a graphic granite, associated with Amazon stone, which also makes a very beautiful green ornamental stone. Over £1500 worth of this is annually sold. The largest crystal found—over four feet in length—of good shape, and all suitable for cutting, was recently sold to the Marquis of Ailsa for £20. The rutilated quartz, or Cupid's Arrows, is found in remarkably fine specimens in North Carolina. Perhaps the most remarkable mass is one 7 inches by 3½, now in the collections of the Academy of Natural Sciences of Philadelphia. The crystals of rutile are about the size of knitting needles. Some of the North Carolina rutile has been cut, furnishing brilliant gems closely resembling carbonado. The rutile geniculated till it forms a perfect circle or rosette, from Magnet Cove, Arkansas, is often mounted and worn as a charm. While opals are found at many places in the United States, they do not rival those of Queretaro, in Mexico. Here are found not only the "milky opals that gleam and shine like sullen fires in a pallid mist," but fire, noble, and almost every other variety known. Rhodonite, in specimens suitable for polishing, is found in Massachusetts and New Jersey. At the latter locality were obtained the finest crystals ever seen. The garnets from New Mexico and Arizona are superior to the Cape rubies from South Africa, and from Alaska the most beautiful crystals ever seen, in a setting of grey mica schist, have recently been obtained.

The New Mexican turquoise is mined to the value of about £700 annually. It has recently been described very fully by Prof. Clarke, Curator of the Mineralogical Department of the National Museum, and is especially interesting as being the material from which the "Chalchuhuitls," or most sacred images of the Aztecs, were made. The Indians still regard it as a lucky stone.

Labradorite, lately so popular for gems and ornamental stones, is found in many localities. The tourmalines of Maine are probably the finest in the world. Here are found the oriental sapphire, ruby, and emerald in perfection. The Shepherd and Hamlin collections contain specimens that are unequalled elsewhere.

Topaz has recently been found at Pike's Peak, Colorado, in large quantity. Some masses weighed two pounds each, and very fine clear white stones have been cut, weighing from 125 to 193 carats. The topaz so nearly rivals the diamond in lustre and brilliancy that it is difficult to distinguish one from the other.

Among ornamental stones should be mentioned a very beautiful variety of serpentine from Maryland called verd-antique, which is being largely used in the interior decorations of the Philadelphia Court House. Another variety resembling jade is the green williamsite from Pennsylvania. Alabaster of various colours abounds in many localities, and marbles, some as beautiful as the mexican onyx, are found in nearly every State. The lovely malachite and azurite, jet, and many other gems of minor importance were referred to but briefly on account of limited time.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 186).

Silica, Ferric Oxide, Alumina, Manganese, Lime, and Magnesia.

ONE grm. was dissolved in HCl, evaporated to dryness, re-dissolved in dilute HCl, and evaporated a second time to render the silica insoluble. It was then re-dissolved in HCl and water (1—3), filtered on a small ashless filter, washed, dried, ignited, and weighed as insoluble siliceous matter. This was fused with five times its weight of dry Na_2CO_3, treated with hot water, and washed into a platinum dish, the crucible treated with acid and carefully rinsed into the dish, the whole acidulated with HCl, evaporated to dryness, treated with water and a little HCl, and evaporated again to dryness. The mass was then treated with HCl and water (1—5) heated to boiling, and filtered on a small ashless filter. The filter was dried, ignited, and weighed. The silica was treated in the crucible with HFl† and H_2SO_4, evaporated to dryness, ignited, and weighed. The difference between this and the weight of the precipitate was SiO_2. Any residue obtained by the treatment with HFl and H_2SO_4 was examined. It might consist of $BaSO_4$ or TiO_2, if either of these existed in the ore, or of a little alumina or ferric oxide, or of a small amount of Na_2SO_4 if the silica was

* From "Mining Industries of the United States."

† The HFl was re-distilled with the addition of a little H_2SO_4 and potassic permanganate from a platinum still, and collected in a platinum bottle, as the crude HFl always contained ferric oxide, beside various sulphur compounds.

not carefully washed. The filtrate from the silica was treated in a platinum dish with NH_4HO, boiled until it smelled but faintly of NH_3, filtered, washed, dried, ignited, and weighed as Al_2O_3, with or without a tinge of Fe_2O_3. To the filtrate, ammonic oxalate was added, the solution was boiled and allowed to stand over night, filtered, washed, and ignited at a high temperature and weighed as CaO.

This filtrate was evaporated down, $NaNH_4HPO_4$ was added, and the solution was well stirred to precipitate the $Mg_2(NH_4)_2P_2O_8$. After standing over night it was filtered, washed, ignited, and weighed as $Mg_2P_2O_7$. Whence 111 : 40 = weight of $Mg_2P_2O_7$: weight of MgO. The sum of the weights of the SiO_2, Al_2O_3, CaO, and MgO should about equal that of the insoluble siliceous matter. When there was a deficiency, alkalies were looked for in another portion. If there was an excess, and the precipitate Al_2O_3 was red, FeO in insoluble matter was determined.

The filtrate from the insoluble siliceous matter was nearly neutralised with Na_2CO_3 solution, 2 grms. of sodic acetate were added, and the whole, after being diluted to about 700 c.c. with hot water, was boiled, and the precipitated ferric oxide, &c., was filtered on a washed filter. The precipitate was washed two or three times on the filter and then transferred back to the beaker with a platinum spatula, the filter was washed with HCl and finally with water, the whole being received in the beaker with the mass of the precipitate. Sufficient acid was added to dissolve the precipitate, and the operation was repeated, the filtrates being added together. The solution of the precipitated ferric oxide, &c., was evaporated to dryness to render insoluble any SiO_2 from the reagents; re-dissolved in dilute acid and filtered into a large platinum dish; the solution was boiled, NH_4HO was added, and the precipitate was collected on an ashless filter, washed thoroughly on the pump with hot water, dried, ignited (finally over the blast), and weighed as $Fe_2O_3Al_2O_3P_2O_5$. The filtrates from the acetate precipitations were evaporated down to about 300 c.c., 2 or 3 grms. of sodic acetate were added, the solution was heated to boiling, and H_2S was passed through to precipitate any Cu, Ni, Co, and Zn.

The precipitate by H_2S was filtered off, and after all smell of H_2S had been boiled off, bromine water was added to the solution. When the precipitated manganic oxide had collected at a gentle heat, and while the solution was still coloured by bromine, it was boiled until colourless, filtered, washed several times, and the manganic oxide was dissolved on the filter in HCl, with the addition of solution of H_2SO_3, which caused its very rapid solution. This solution was evaporated to dryness, re-dissolved in HCl and water, a slight excess of NH_4HO was added, nearly all smell of NH_3 was boiled off, the solution was filtered, any slight precipitate of Fe_2O_3, &c., was re-dissolved, and re-precipitated and filtered as before. The filtrates were added together and excess of—

$$Na(NH_4)HPO_4$$

was added with enough HCl to render the solution decidedly acid, and after boiling for some time, an excess of NH_4HO was added to precipitate the $Mn_2(NH_4)_2P_2O_8$. This was boiled until the precipitate became crystalline and the solution smelled but slightly of NH_3, when it was filtered, washed with cold water, ignited, and weighed as $Mn_2P_2O_7$, which, multiplied by 0·5, gave MnO.

To the filtrate, from the precipitate of manganic oxide by bromine, was added the ammoniacal filtrate from the final precipitation of the Fe_2O_3, Al_2O_3, and P_2O_5; the whole was evaporated down to about 400 c.c., and the lime and magnesia were precipitated as described in the analysis of the insoluble siliceous matter. There were several sources of error which it was found very necessary to guard against in the above analysis, namely, the contamination of the distilled water by silica when it was boiled in glass, the strong action of ammoniacal solutions on the beakers, and the presence of silica, alumina, ferric oxide, lime, and magnesia in many reagents, and especially in sodic carbonate. Distilled water which had been heated over night in a Bohemian flask on the sand-bath was found to contain 52 milligrms. of solid residue to the litre, 26 milligrms. of which was SiO_2; and Fe_2O_3 precipitated from a solution to which water boiled in a flask from 2 to 6 hours had been added, contained after ignition as much as 3 per cent of SiO_2. To avoid this, tin-lined copper flasks were used for heating distilled water, and to avoid the error due to the action of ammonia salts and ammoniacal solutions on the beakers, all the precipitations and evaporations were made in platinum. We were fortunate enough to obtain some remarkably pure sodic carbonate containing only 2 milligrms. of SiO_2, 1½ milligrms. of Al_2O_3, 2 milligrms. of CaO, and 2 milligrms. of MgO to the 100 grms. from Messrs. Powers and Weightman, Philadelphia.

Nickel, Cobalt, and Zinc.

Three grms. of ore were treated as if for the determination of manganese, and the sulphides of Cu, Ni, Co, Zn were precipitated from the boiling solution of the acetates by H_2S. This precipitate was collected on a small filter, washed with H_2S water containing a little acetic acid, dried, ignited in a porcelain crucible, and transferred to a small beaker. It was then treated with HCl and a little HNO_3, evaporated to dryness, re-dissolved in HCl, diluted, boiled, and the Cu was precipitated by H_2S. The CuS was filtered off and washed with hot water, the filtrate containing the Co, Ni, and Zn was evaporated to dryness, re-dissolved in a few drops of water containing not more than two or three drops of HCl, and an excess of K_2NO_2 acidulated with acetic acid added. After standing for a day or two the potassic cobaltic nitrite was filtered off, washed once or twice with a strong solution of potassic acetate, and then, after removing the filtrate, with alcohol to displace the alkaline salts. The precipitate was then ignited very carefully in a porcelain crucible, treated with H_2SO_4 to decompose all the nitrite, made alkaline with NH_4HO, filtered, and the Co was precipitated by the battery; or the ignited precipitate was dissolved in a few drops of HCl, transferred to a small beaker, diluted, and any Al_2O_3 and Fe_2O_3 present was precipitated by boiling for several hours with an excess of sodic acetate. The precipitate of Fe_2O_3 and Al_2O_3 was filtered off, the filtrate was made alkaline with ammonia, and the cobalt was precipitated as sulphide by NH_4HS. The precipitate was allowed to settle, filtered off on a small ashless filter, washed, dried, ignited, and weighed as CO_2S, or treated with H_2SO_4 and zinc and weighed as CoS_4, which, multiplied by 0·4872, gave CoO.

The filtrate from the potassic cobaltic nitrite was acidulated strongly with HCl and heated to decompose all the nitrite, and the NiO was precipitated by an excess of NaHO or KHO, filtered, and the filtrate was tested for ZnO with NH_4HS. If any ZnS was found, the NiO was re-dissolved and precipitated as before, filtered, and the filtrate and washings were added to the first filtrate, the ZnS was allowed to settle, filtered, washed with water containing NH_4HS, re-dissolved in HCl, and evaporated to dryness. This was treated with dilute HCl, filtered, and the zinc was precipitated by solution of Na_2CO_3, filtered, washed, dried, ignited, and weighed as ZnO.

The precipitate of NiO was dissolved on the filter in HCl, the filtrate run to dryness with H_2SO_4, diluted, excess of NH_4HO was added, filtered, and the Ni precipitated by the battery; or the HCl solution was evaporated to dryness, dissolved in a drop or two of HCl, diluted, and boiled with an excess of sodic acetate. Any precipitate of Al_2O_3, &c., was filtered off, excess of NH_4HS was added, then an excess of acetic acid and H_2S was passed through the boiling solution. The precipitated NiS and S were collected on a small ashless filter, dried, ignited, heated with a little ammonic carbonate, and weighed as Ni_2S.

Determination of Ferrous Oxide.

One grm. of finely ground ore was weighed into a flask, A (Fig. 4), of about 100 c.c. capacity, fitted with a rubber

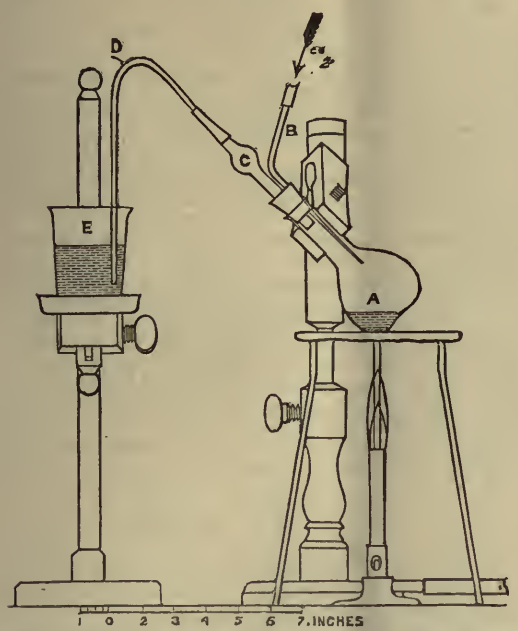

Fig. 4.—Apparatus for determination of FeO soluble in HCl.

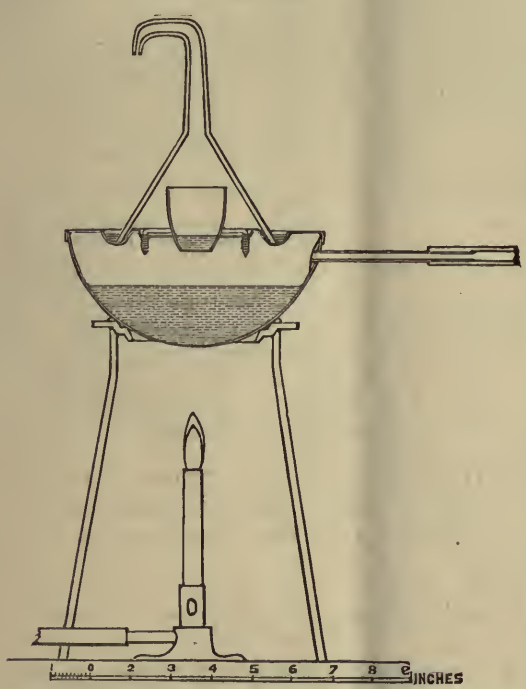

Fig. 5.—Apparatus for determination of FeO in insoluble Residue.

stopper, through which passed two glass tubes, as shown in the cut. Dry CO_2 was passed in through the tube B, to expel the air through the tubes C and D, the latter dipping beneath the surface of the water in the beaker E, and when this was accomplished the stopper was removed, 15 c.c. of strong HCl was quickly poured in, the stopper was replaced, and the ore was dissolved with the aid of heat, the current of CO_2 being continued uninterruptedly. When the solution of the ore was accomplished the source of heat was removed, and the current of CO_2 being temporarily stopped, the water in the beaker B was allowed to run back into the flask, A, until the latter was nearly filled, when the current of CO_2 was turned on again and allowed to continue until the solution in the flask was thoroughly cooled. This was accomplished by removing the tripod, C, placing a dish nearly filled with cold water under the flask, and replacing the tripod. The solution was then washed out into the dish used for titrating, into which 3 grms. of zinc dissolved in 15 c.c. of the dilute H_2SO_4 (1—1) were previously poured, and the whole was diluted to 1 litre. The amount of ferrous oxide was then determined by the potassic permanganate solution. The amount of solution required to colour about 1 grm. of ferric chloride diluted to the same bulk and containing the same amount of H_2SO_4 was subtracted from the amount required for the titration before calculating the amount of ferrous oxide.

Ferrous Oxide in Insoluble Siliceous Matter.

When the insoluble siliceous matter contained iron in the ferrous condition, for instance, in the form of epidote, 1 grm. was treated with HCl diluted, and the insoluble matter was collected on the felt in a pierced crucible, carefully dried, transferred with the felt to an ordinary platinum crucible, and treated, in the apparatus of Fig. 5, with HFl and HCl in a current of CO_2. When entirely decomposed it was allowed to cool, the current of CO_2 being kept up, and then transferred quickly to a dish containing about 1 litre of water and 15 c.c. of the dilute H_2SO_4 and zinc, the crucible was washed out, and the amount of FeO was determined by the standard solution of potassic permanganate.

Sulphuric Acid.

Sulphuric acid may exist in the ore in the form of baric sulphate, calcic sulphate, or as sulphates of iron, &c., formed in the roasting or weathering of an ore containing pyrites. When it existed as baric sulphate it was found, in the analysis of the insoluble siliceous matter, in the residue remaining after the treatment of the silica with HFl. In this case the residue was fused with Na_2CO_3, treated with hot water and filtered. The filtrate was acidulated with HCl, and the sulphuric acid was precipitated by baric chloride and determined as $BaSO_4$, which, multiplied by 0·3433, gave SO_3.

The baric carbonate on the filter was dissolved in dilute HCl, H_2SO_4 was added, and the $BaSO_4$ was finally weighed, which, multiplied by 0·6567, gave BaO. In the other cases 10 grms. of the ore finely ground were treated with water containing a little HCl, filtered, the sulphuric acid was precipitated in the filtrate as $BaSO_4$, and the weight was determined with the usual precautions.

Alumina.

The total amount of the soluble $Fe_2O_3+Al_2O_3+P_2O_5$ was added to the $Al_2O_3+Fe_2O_3$ found in the insoluble siliceous matter, and from this was subtracted the P_2O_5, which gave the total, $Fe_2O_3+Al_2O_3$. From this was subtracted the Fe_2O_3 found by titration; the difference was Al_2O_3. The accuracy of this result depended, of course, upon that of the volumetric determination of the Fe_2O_3. The comparison of many analyses showed that the error due to this need never exceed a few hundredths of 1 per cent, and no direct method was found to yield results equally accurate or concordant.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 16, October 17, 1887.

Researches on Drainage.—M. Berthelot.—The nitrogen carried off from the soil by drainage is from 24 to 26 times greater in quantity than the nitrogen brought down in the rain. The total ratio of the ammoniacal nitrogen to the nitric nitrogen in rain-water differs little from 3 : 1. About two-thirds of the rain-water evaporate or are retained in the soil.

The Application of Heat to Cider.—G. Lechartier.—A temperature of 60° arrests all further fermentation in cider, even if it contains as little as 2 per cent of alcohol, and enables them to be kept for twelve months without any change in the proportion of sugar or of alcohol.

A New Method of Preparing Substituted Safranines.—Ph. Barbier and L. Vignon.—The authors have obtained the tetramethylo-diamido-azo-benzol of dimethyl-pheno-safranine by the action of para-nitroso-dimethyl-aniline hydrochlorate upon aniline in an alcoholic solution. In a future communication they will describe a novel method for the formation of safranines by the action of the amido-azo derivatives upon mono-nitro-mono-benzinic carbides in presence of reducing agents.

Formation-heat of Zinc-ethyl.—M. Guntz.—Zinc-ethyl is formed with a considerable absorption of heat, whether we set out from its elements or from ethylene hydride and zinc.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., June, 1887.

Patents taken out at Berlin.—These patents comprise:—

Process for the preparation of oxygenated water, by Siegfried Lustig. L. No. 3927.

Process for obtaining pyrosulphates of the fixed alkalis and ammonia. H. Baum, B, No. 7344.

Manufacture of sodium and potassium. Hamilton Y. Castner. C, No. 1981.

Obtaining from suint hard or soft grease or a product named laneline, as well as free fatty acids. Dr. von Rad. R, No. 2926.

Preparing hydrazoines by the condensation of hydrazo-compounds with the aldehyds. Dr. Hans Cornelius. C, No. 2049.

Azo-colours prepared with the para-diamines of stilbene and fluorene. Berlin Joint Stock Aniline Co. A, No. 1480.

Preparation of Resorcine Blue. Haydn Mozart Baker. B, No. 7027.

Azo-colours derived from the bi- or tetra-halogenous products of benzidine. Ewer and Pick. E, No. 1843.

Preparation, of blue, blue-violet, and violet colouring-matters by condensations of aromatic hydrazo-compounds with aromatic nitroso-derivatives. Dr. Benno Homolkel. H, No. 6207.

Colouring matters of the rosaniline group obtained by the condensation of para-nitro-benzoic aldehyd with hydrocarbides. Dr. F. Stolz. S, No. 1676.

Improvement in the preparation of dimethyl-phenyl-oxypyrazol. Meister, Lucius, and Brüning. F, No. 3008.

Manufacture of a colouring-matter with disulphonic anthraquinone acid. W, No. 4567.

Transformation of the tetra-methylated and tetra-ethylated diamido-benzophenones into the corresponding derivatives of thio-benzophenone. Meister, Lucius, and Brüning. B, No. 7126.

Preparation of a colouring-matter named styrogallol by means of gallic acid or tannin. E. Jacobsen. J, No. 1423.

Improvements in the preparation of blue-black azo-colours. L. Casella. C, No. 1945.

Preparation of the homologues of benzidine. Ewer and Pick. E, No. 1840.

Red colouring-matters prepared with isoquinoleine. Berlin Joint Stock Aniline Co. A, No. 1564.

Scarlet azo-colours obtained by the reaction of tetrazo-diphenyl and tetrazoditolyle with resorcine. K. Oehler. O, No. 827.

Process for separating paratoluidine from its mixtures with orthotoluidine and aniline. A. Wulfing. W, No. 4576.

Preparation of a new naphthol-monosulphonic acid. L. Casella. C, No. 2091.

Yellow colouring matters resulting from the condensation of hydrazine-sulphonic acids with isatine and methyl-isatine. Berlin Joint Stock Aniline Co. A, No. 1621.

Orange and red colours obtained by the reaction of phenanthrenequinone with the aromatic sulphonic hydrazines. Same Company. A, No. 1620.

Azo-colours dyeing cotton directly in an alkaline bath in violet and blue shades. Same Company. A, No. 1583.

Mixed azo-colours derived from the tetrazo-compounds of diphenyl or ditolyl. A, No. 1399.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Destroying Fish.—It is intended to destroy the whole of the pike, perch, dace, and roach in a small lake near here, and to re-stock with lake trout in the spring of the year. The lake is now as low as it can be, and is lower than has been known for the past 20 years. A fish preservation society has been formed, and I write at their request to ask you the best means of destroying these fish. There is about 2,000,000 gals. of water in the lake at the present time, and the water has to travel in a small rivulet before it reaches a trout stream, and of course the fish in this stream must not be damaged in any way.—JOHN TAYLOR.

MEETINGS FOR THE WEEK.

MONDAY, November 7th.—Royal Institution, 5. General Monthly Meeting.

—— Society of Chemical Industry, 8. "Note on the Comparative Antiseptic Action of Chlorides, Nitrates, and Sulphates," by Mr. C. T. Kingzett, F.I.C., F.C.S. Discussion on Mr. John Ruffle's paper, "The Correct Analysis of Superphosphates, Plain and Ammoniated."

SATURDAY, 12th.—Physical, 3. "On the Rotation of a Solid Copper Sphere and of Copper Wire Helices when freely suspended in a Magnetic Field," by Dr. R. C. Shettle. "On a Geometrical Method of determining the Conditions of Maximum Efficiency in the Transmission of Power by Alternating Currents," by T. H. Blakesley.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1459.

NOTE ON THE CORROSION OF THE BOILERS OF LOCOMOTIVES.

By R. W. EMERSON MACIVOR, F.I.C., F.C.S., F.R.G.S., &c.

It having been found that the water supplied to the locomotives running on certain newly-opened lines of railway in the colony of Victoria acted injuriously on the boilers, I was called in to investigate the matter, and, if possible, suggest an easy means of preventing the corrosion. The then Minister for Railways, the Hon. John Woods, furnished me with numerous samples of the waters used for feeding the engines on the Colac and Horsham lines, and I found all of them to be highly charged with mineral salts. Next to chloride of sodium, chloride of magnesium was the most abundant constituent, and to this substance I attributed the results complained of, on account of its property of partially decomposing, even when in solution, in such a way as to yield free hydrochloric acid. The engines on the Colac line were supplied from a lake, and did not suffer so much as those on the Horsham line, which were fed with the more saline waters of the Jung-Jung and other creeks.

In the case of the creek waters I may mention that several of the samples contained as much as 700 grains of salts per gallon, of which nearly one-third consisted of chloride of magnesium. But the total salts in Australian waters vary much with the seasons, being often very low in winter and high in summer. Jung-Jung creek water has been found to contain as little as 36 grains per gallon in winter and nearly 800 grains in the middle of the following summer. This accounts for the fact that the corrosive action of the water is insignificant during one part of the year and rapid in another.

The only remedy I could suggest was the addition of soda-ash to the reservoirs in which the waters were stored, and, so far as I know, the results have not been unsatisfactory.

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN,

AND ON THE

CHEMICAL STRUCTURE OF THE TWO LATTER BODIES AND THEIR DISSOCIATION IN THE ATMOSPHERE OF THE SUN.

By Professor A. GRUENWALD.

(Continued from p. 188).

Spectrum of the Element *a*. λ=	Solar Spectrum according to Angström. λ=
9842·4	—
7290·2*	7290
6510·2	6511
6150·6	6150·5
5653·5	5653·3

(With possible error up to an Angström's unit. The two first wave-lengths are much more accurate than the following, as they have been deduced from the wave-lengths of H_α and H_β, as most carefully measured by Mendenhall).

* Almost coincides with a telluric line 7290·3 (Fievez).

Spectrum of Element *b*.	Solar Spectrum.
5954	5953·9
5951·8	5951·6
5943	5943·5
5940	5940
5924·4	5923·5
5916	5915·4
5904	5904·6
5899·3	5899
5897	5897
5892·1	5892·1
5886	5885·5 5886·5
5874·5 Chrom.	5874·9 Helium line.
5855·4	5855·2
5833	5832·5
Lines from 5808 to 5805	5808·2 5807·2 5805·7 5804·4 5803·5
Lines from 5793 to 5784	5793 5792·4 5790·3 5786·8 5784·5 5783·0
5775	5774
5752·5	5752·2 5751·8
5694·1	5694
5618·2	5618·0

Spectrum of Element *b*.	Solar Spectrum.
5593·3	5593
5577·3	5577·5
5560·1	5559·6
5535·6	5536·2
5524·3	5524·8
5515·9	5515·5
5511	5511·2
5494·1	5493·8
5485·5	5485·6
5482·3	5482·5
5479·5	5479·9
5455·1	5454·8
Chrom.	5454·7
5417·2 Chrom.	5417·9
5412·6 Chrom.	5412·4
5403·7 Chrom.	5403·1
	5403·0 to 5403·3
5389·5	5389·6
5376·4	5376·5
5364·0	5364·0 *Fe* 5364·2
5340·0 Chrom.	5340·2 *Fe* ? Mn. ?
5326·5	5327·0 *Fe*
5274·1	5274·7
5260·1	5259·6
5199·9 Chrom.	5199·7
5187·0 Chrom.	5187·3 (alleged *Ti*)
	&c.

Although the fundamental proposition (I.) was originally deduced only for the combinations of primary elements, it holds good (which is very important) at least with a close approximation for the combination of compound radicles in as far as they really behave like atoms. A proof of this, and at the same time a very important and weighty confirmation of my theory, is the fact that the wave-lengths of nearly all hydrogen and oxygen rays, when multiplied by $\frac{8}{9}$ (the mean condensation factor of H and O on their combination to H_2O) become transformed into wave-lengths of the corresponding H_2O rays, at least so far as the H_2O spectrum is known and is available for comparison.

3. On searching for the reduction-factor of the primary constituent, *a*, of the H_2O spectrum very remarkable relations resulted. It appeared that the ray 4158, into which the main ray H_α 6562 of H is converted by multiplication with 0·6336, is a hitherto unknown ray of the H_2O spectrum, and that by means of the factor $\frac{8}{9}\frac{9}{9}$ it can be reduced to another strong ray λ = 3080 of the H_2O spectrum. The ray 4158 occurs among a group of rays (3986, 4005 to 4645) which Vogel observed in the spectrum of rarefied hydrogen (obtained either electrolytically or from potassium formiate), but whose derivation from H is very doubtful. Considering that on preparing H in these manners an admixture of watery vapour is not easily avoided, it becomes very probable that some, at least, of the doubtful rays, especially the ray 4158, owe their origin to the traces of watery vapour mixed with the hydrogen. These rays are at first very faint, but become visible in presence of hydrogen, being strengthened by its harmonious vibrations. If this conjecture is well founded we may expect that the wave-lengths of those rays of Vogel's which belong to the same group as 4158 can likewise be reduced to the H_2O spectrum by the factor $\frac{8}{9}\frac{9}{9}$. This conjecture proved itself correct to a surprising degree, especially for the rays 3986, 4005, 4047, 4065, 4067, 4078, 4152, 4158, 4168, 4193, 4201, &c., so that these belong to the H_2O spectrum, and on division by 0·6336 pass into corresponding very faint hydrogen rays, as yet unknown with the exception of H_α. Their approximate wave-

lengths are here placed in juxtaposition with the nearest lines of Angström's solar spectrum.

H rays.	Solar Spectrum.
6291	6291·4
6321	6321·5
6387·3	?
6415·7	Chromosphere Young. 6415·6
6418·9	6418·7
6436·2	(6438 ? Ca)
6553·0	?
H_α 6562	6562
6578·3	Chromosphere Young. 6576·9 ?
6617·7	?
6630·3	?

(With possible errors up 1·6 Angström unit).

A careful comparative examination of the spectra of portions of hydrogen purposely mixed with different very small quantities of watery vapour would be very useful, and might furnish experimental confirmation as to the origin of the rays 3986, 4005, 4047 . . . . 4201, &c. The ray 4158 falls very close to another faint ray 4158·7 of the second so-called compound H spectrum observed by Dr. B. Hasselberg if the latter is not identical with the former, and likewise owes its origin to a trace of watery vapour. The same ray was also observed by Plücker in the same manner as well as in atmospheric air and in oxygen.

4. *α*. The wave-lengths of the elementary line spectrum of oxygen resolve themselves into two groups (H′) and (O′), of which the former consists of certain rays of the second compound hydrogen spectrum, and on multiplication by $\frac{1}{4}$ passes over into the corresponding group of the H_2O spectrum.

β. The group (O′) can be divided into two groups (*b*′) and (O″), so that the one group (*b*′) on multiplication with $\frac{3}{2\frac{1}{2}}$ passes into a group of corresponding wave-lengths of the H_2O spectrum, and on multiplication by $\frac{1}{4\frac{1}{2}}$ into a group of homologous wave-lengths of the primary matter, *b*, existing in H in chemical combination. The other group (O″) on multiplication by $\frac{1}{3}$ is converted into a corresponding group of the H_2O spectrum.

γ. The latter group (O″) may again be resolved into two groups of wave-lengths (*b*″) and (*c*). The former, (*b*″), is so constituted that on multiplication by $\frac{3}{2\frac{1}{2}}$, it is reduced to one group of the H spectrum, and on multiplication by $\frac{1}{7\frac{1}{2}}$ to a corresponding group of the H spectrum, which latter belongs to the primary matter, *b*, in H.

The second group, *c*, is converted by multiplication with $\frac{3}{8}$ into a homologous group of H_2O rays.

(To be continued).

THE PHENOMENON OF DECREPITATION IN ORGANIC SUBSTANCES.

By DAVID HOOPER, F.C.S., Government Quinologist.

DECREPITATION is usually defined as "the crackling of certain salts when suddenly heated, acccompanied by a violent exfoliation of their particles." Illustrations of this phenomena are found in some anhydrous salts, such as potassium chlorate, sodium chloride, and plumbic nitrate; certain natural minerals having distinct crystalline structure; and a few imperfect conductors of heat, as glass and cast-iron,—all of which are organic.

Two causes are assigned to the behaviour of these bodies when heated. In the crystals, water is mechanically enclosed between the solid particles, and the explosion is owing to the expansive force of the steam suddenly generated. In the non-crystalline substances there is an unequal expansion of the laminæ which compose the mass, and a consequent breaking up as the heat is conducted into it.

In the analysis of organic compounds it must have been often observed that, in evaporating aqueous and alcoholic extracts to dryness, a crackling frequently takes place as they are cooling, the film of dry extract becomes fissured in all directions, and some portions are detached and fly off or fall to the bottom of the vessel in which the operation is conducted.

A peculiar phase of this phenomenon was noticed some months ago, when examining the bark of *Michelia Nilagirica*. The tannin had been precipitated by cupric acetate, and the washed precipitate in a moist state was dried in a water-oven, and weighed when it ceased to lose water. The tannate of copper, left in a glass dish, in a few moments began to crackle, and fragments of the compound became disrupted and fell like a shower upon the counter, covering it within a radius of some 10 to 12 inches.

This peculiarity was noticed a second time during the investigation of a resin in *Musambra*, a country-made aloes of India. The purified resin, insoluble in acetic acid, was dried at 100° C., and weighed. A few moments afterwards the precipitate began to crack, and great commotion ensued as small splintery fragments were violently ejected on all sides. This continued for about fifteen minutes, when the fountain ceased. The loss of resin amounted to about 5 per centum. Another quantity of this resin was precipitated and dried altogether over sulphuric acid until it became constant in weight; it was then transferred to a water-oven and dried at 100° C. In this case no decrepitation took place after being cooled, but the resin gradually assumed the amount of moisture it held previous to its desiccation at 100° C.

The explanation of the cause of this phenomenon in organic extracts might with very good reason be the same as that which is used in the physical description of the old "Rupert's drop." There seems to be in both an accidental cohesion of matter having elastic properties. The rapid drying of the resin, from a moist to an anhydrous condition, unequally contracted the mass without allowing it an opportunity to assume its natural state when combined with water of hydration. In regaining this water an expansive force was exerted on the exterior portions of the mass, and caused the violent disruption of the particles. As a practical matter this inconvenience might be avoided by the more careful and not too rapid drying of these substances.

In evaporating a chloroformic solution of pure strychnine in an assay of nux vomica, a spluttering often takes place as the final portion of the solvent is being dissipated. This is a different case to those I have been describing. Here the decrepitation, if it may be so called, occurs during the evaporation, and not during or after the cooling. It appears to be due to the assumption of the crystalline state or by the alkaloid on the immediate disappearance of the chloroform.

Ootacamund, India,
October 11, 1887.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 199).

Calculation of the Analysis.

THE S in the sulphuric acid found as such was subtracted from the total S; so much as was necessary to form the sulphides of Cu, Ni, Co, Zn, Sb with the amounts of these elements in the ore, and supposed to exist in this

* From "Mining Industries of the United States."

condition, was subtracted from this, and the remaining sulphur was calculated to FeS_2. The amount of Fe required for this was calculated to Fe_2O_3, and subtracted from the Fe_2O_3 found by titration. From this was taken the amount of Fe_2O_3 calculated from the FeO found in the determination of ferrous oxide, and the result was the amount of Fe_2O_3 existing in this state in the ore.

Carbonic Acid.

Three grms. of ore were weighed into the flask, A, of the apparatus (Fig. 6), and the connections were made as there shown; 10 c.c. of strong H_2SO_4 were added to 65 c.c. of water and poured into the bulb-tube, B, the stop-cock, C, having first been closed. After the potash bulb and the drying tube were weighed they were attached to the apparatus, the tube, S, was filled with fused $CaCl_2$, being added to prevent the drying tube, R, from absorbing moisture from the atmosphere. The U-tube, O, was

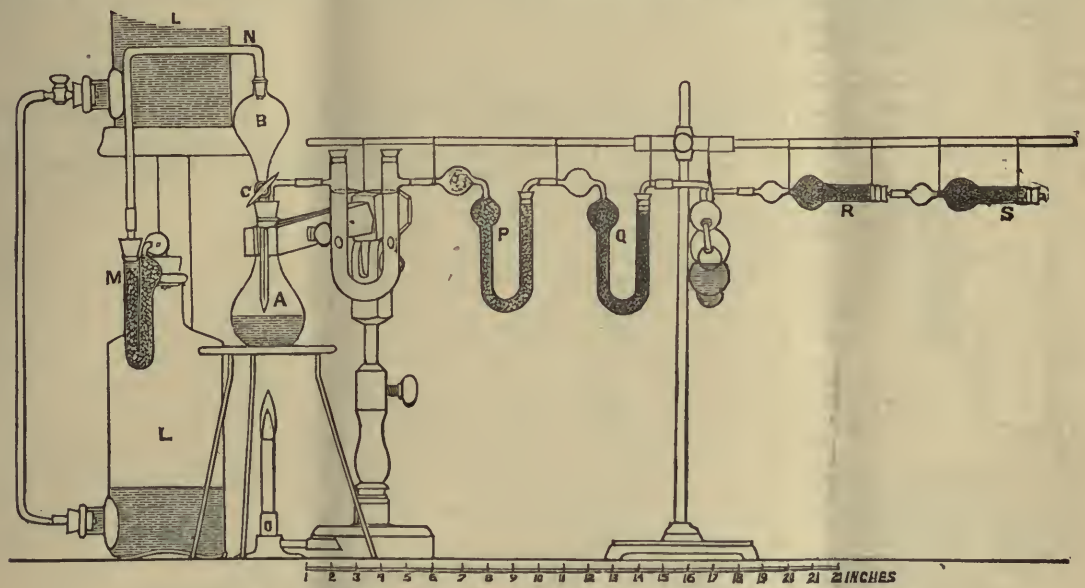

FIG. 6.—APPARATUS FOR DETERMINATION OF CO_2 IN IRON ORES.

empty. P was filled with pumice saturated with anhydrous $CuSO_4$, and Q with dried $CaCl_2$. When the connections

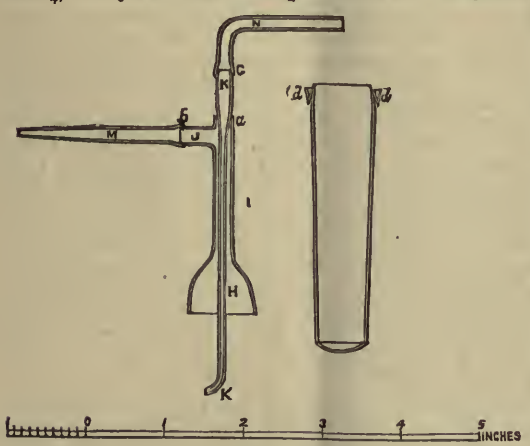

FIG. 7.

were all proved to be tight, the tube, N, was fitted into the neck of the bulb-tube with a piece of rubber tubing, and the acid in the bulb was allowed to run into the flask very slowly, and when it was all in, a slow current of air was forced through the apparatus by means of the bottles L L. The air was freed from CO_2 by potassic hydrate in the tube, M. As soon as the current of air was started, the flask, A, was heated gradually, and finally the solution was boiled until the bend of the tube, O, was filled with condensed water. It was then allowed to cool while the current of air was continued. The potash bulb and the drying tube were detached and weighed with the usual precautions; the increase of weight, of course, was the CO_2 due to the carbonates contained in the ore.

Water and Carbon in Carbonaceous Matter.

Many ores besides blackbands contain carbon; for instance, several ores from New Jersey contain graphite, and nearly all limonites and magnetites contain carbon in organic matter, probably from the organic acids which originally held the iron in solution. As pyrites was also of common occurrence in such ores, it was necessary to devise some method by which the water of composition and the carbon could be determined in the presence of pyrites. In attempting to determine the water by heating the ore in a current of air, some H_2SO_4 was always formed and driven over into the drying tube, and some organic matter was certain to be dissolved if the ore was treated with acid for the determination of the carbon. It was found by careful experiments that when a carbonate of any kind was fused with potassic anhydrodichromate in excess, the CO_2 was all expelled together with any water present, while pyrities treated in the same way was oxidised with formation of potassic sulphate, which was not decomposed even at a bright red heat.

A very practical and easy way to apply this in the treatment of ores was afforded by the use of Dr. Gooch's tubulated crucible,* (Fig. 7), and the process was as follows:—

For ores containing much water or carbonic acid, 1 grm., and for others 3 grms., were weighed into the crucible, A, of Fig. 8, and carefully mixed, by means of a rod or wire, with 7 grms. of $K_2CrO_4CrO_3$, which had been previously fused and powdered; the cap, B, was adjusted, and the whole was placed in the air-bath and heated to 100° for a short time. The crucible was then placed on the platinum

* *Am. Chem. Journ.*, vol. ii, p. 247. CHEM. NEWS, vol. xlii., p. 326.

triangle, C, and connected by means of a cork with the weighed tube, D, containing dried $CaCl_2$, and the weighed potash bulb, E, and drying tube, F, were attached, the latter guarded by the $CaCl_2$ tube, G, as can be seen in the sketch.

The cap for the crucible consists of a conical cover, H, drawn out vertically into a tube, I, into which is burned a horizontal tube, J, of the same diameter. Though the top of the tube, I, passes the tube, K, to a distance of ¼ inch below the bottom of the cap, the end being slightly bent; K is burned into I at its point of entry, *a*, sealing I at this point. A straight glass tube, M, drawn tapering, is fused to the platinum tube, J, at *b*, and another piece, N, is bent at a right angle to the platinum tube, K, at *c*. A piece of rubber tubing closed with a piece of glass rod at one end, was drawn over the end of the tube, N, the space around

for about fifteen minutes, when the lamps were turned out and the whole was allowed to cool in the current of dried air from the bottle, L. The tubes were then re-weighed; the increase in the weight of D was the weight of the water of composition in the ore, and that of the potash bulb and drying-tube the weight of the total CO_2. This latter, of course, was the sum of the CO_2 due to the carbon of the carbonaceous matter or graphite, and of that due to the CO_2 in the carbonates. The amount of the latter (previously determined) was subtracted from the total CO_2, and the difference, multiplied by 0·2626, gave the carbon in carbonaceous matter, or the graphite.

Alkalies.

The alkalies were generally confined to the insoluble siliceous matter in the ores, but were occasionally found

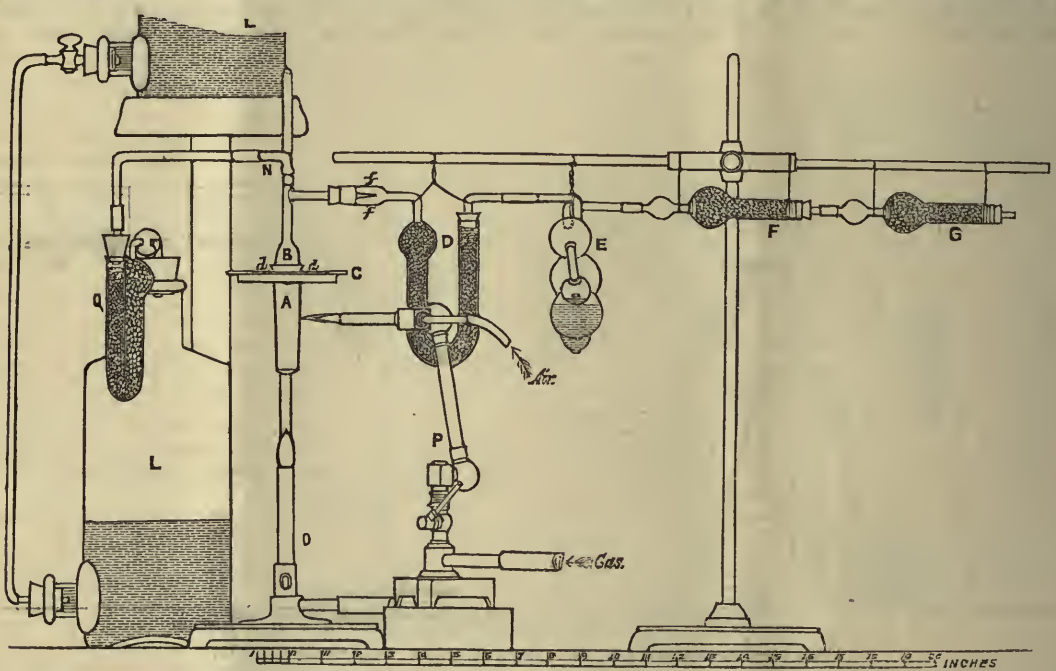

FIG. 8.—APPARATUS FOR DETERMINATION OF WATER AND CARBONACEOUS MATTER IN IRON ORES.

the cap in the flange, *d*, was filled with small pieces of neutral anhydrous sodic tungstate, which were fused by means of a blowpipe flame, making an air-tight joint. The mixture in the crucible was kept cool during this operation by dipping the end in a beaker of cold water. The expansion of the air in the apparatus during the heating caused it to bubble through the potash bulb, and the reflux of the solution in the bulb as the apparatus cooled was a good index of the tightness of the joints. When the joints were shown to be all tight the cap was removed from N, and the bottle, L, was connected with N, as shown in the sketch. A slow current of air, freed from CO_2 and water by passing through the tube, Q, containing KHO and $CaCl_2$, was then started through the apparatus, and the crucible was heated very gradually and cautiously by the burner, O. As the steam was gradually driven into the drying-tube it was not allowed to condense at *f*, but was driven forward into the $CaCl_2$ by the heat of a small alcohol lamp applied to the drying-tube at this point. When the greater part of the water had been thus driven over, the crucible was heated by a horizontal flame from the blast-lamp, P, above the level of the mixture, to prevent the latter from frothing up and stopping the end of the tube, K. The bottom of the crucible was gradually heated to a dull red and allowed to remain at this temperature

in the portion soluble in HCl. In the former case 5 or 10 grms. of the ore were digested in HCl until only the silicates remained undissolved, diluted, and filtered. The insoluble residue was washed, dried, ignited, and treated in the crucible with HFl and H_2SO_4 until it was entirely decomposed; it was then evaporated down until all the HFl and nearly all the H_2SO_4 volatilised. It was then treated with hot water and a little HCl, if necessary; the clear solution was transferred to a small platinum dish, the Al_2O_3 and Fe_2O_3 were precipitated by NH_4HO, and the solution was boiled until nearly all NH_3 was driven off. It was then filtered into another platinum dish, evaporated to dryness, and heated until all the ammonium salts were volatilised. The residue was treated with a little water, a few drops of ammonic oxalate and excess of NH_4HO, and the solution was boiled and filtered. The filtrate was evaporated to dryness, and the residue was heated to dull redness. It was then treated with water, filtered, and an excess of baric hydrate* was added to precipitate the sulphuric acid and magnesia. The solution was boiled and filtered from the $BaSO_4$, and the filtrate was evaporated to dryness, after the addition of a

* Made by treating ordinary $BaCO_3$ with tolerably strong HNO_3, and washing the baric nitrate with HNO_3. The baric nitrate was dried and fused until all the HNO_3 was driven off.

little ammonic carbonate and hydrate. The residue was treated with a little water, filtered to get rid of the $BaCO_3$, and the filtrate was evaporated to dryness and heated carefully to volatilise any ammonium salts. The residue was treated with water, filtered into a small weighed platinum dish; the filtrate was acidulated with HCl, evaporated to dryness, heated carefully to a very low red, and weighed as quickly as possible as alkaline chlorides.* The alkaline chlorides were then dissolved in water, any residue was filtered off, weighed, and its weight subtracted from the weight of the chloride, an excess of platinic chloride was added, and the solution was evaporated on the water-bath until the syrupy liquid solidified on cooling. The residue was treated with alcohol 95 per cent, filtered on the felt, washed with 95 per cent alcohol, dried at 120° C., and weighed as K_2PtCl_6, which, multiplied by 0·1931, gave K_2O. The weight of the K_2PtCl_6, multiplied by 0·3056, to reduce to KCl, was subtracted from the weight of the alkaline chlorides, and the difference (NaCl), multiplied by 0·5299, gave Na_2O.

The filtrate from the K_2PtCl_6 was evaporated to dryness in a platinum dish, with the addition of a little oxalic acid to decompose all the platinic chloride; the residue was treated with water, filtered, and any MgO was precipitated by microcosmic salt and weighed as $Mg_2P_2O_7$, which, multiplied by 0·428, gave the amount of MgCl to be subtracted from the weight of chlorides to get the amount of alkaline chlorides.

For the estimation of alkalies in the portion of the ore soluble in HCl, 1 grm. was treated with HCl, diluted, filtered into a platinum dish heated to boiling; a slight excess of NH_4HO was added, and the whole was evaporated to dryness in the air-bath to render the Fe_2O_3 very granular and easy to wash. It was then treated with water, a drop or two of NH_4HO was added, and the Fe_2O_3, &c., filtered off and washed. The filtrate, after the addition of a drop or two of H_2SO_4, was evaporated to dryness, and the ammoniacal salts were driven off by ignition. The residue was treated with water, a little ammonic oxalate was added to precipitate the lime, and the alkalies were determined, as in the former case, after the precipitation of the calcic oxalate.

(To be continued).

* Mixed with a little $MgCl_2$.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, November 3rd, 1887.

Mr. WILLIAM CROOKES, F.R.S., President, in the Chair.

SIR BENJAMIN V. S. BRODIE, Bart., and Messrs. L. O. Simmons, William Bott, and Edward D. Gravill were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Horace Woodward Crowther, Hope Street, West Bromwich; Frank Calder, University College, Bristol; T. Arthur Dickson, 28, Cross Street, Manchester; Charles A. Fawsitt, 4, Maule Terrace, Partick, Glasgow: David Ranken S. Galbraith, Auckland, New Zealand; Joseph C. August Hall, Grosvenor House, Swansea; Casimir James Head, Landore Steel Company, Swansea; James Garnett Heywood, 68, Sutherland Avenue, Maida Vale, N.W.; Walter Hogben, Monville, Seine Inférieure, France; Samuel Lees, Jun., Park Bridge, Ashton-under-Lyne; David Lennox, M.D., 144, Nethergate, Dundee; Eberhard Luttgen, 1814, Mervine Street, Philadelphia, Penna.; Angus Mackay, Sydney, New South Wales; Sidney Martineau, South Road, Clapham Park, S.W.; William Edward Matthews, Kosferd Place, Albert Park, Melbourne; John A. Miller, B.Sc., 16, North Pearl Street, Buffalo, U.S.; John McArthur, 5, Glen Avon Terrace, Partick, Glasgow; John C. H. Mingaye, Taylor Street, Garramatta, Sydney; Archibald R. Ormiston, Heathland, Uddingston; Julius Ostersetzer, Goulding's Chemical Manure Works, Dublin; Andrew William Taylor, Truman Street, Nottingham; Arthur Twivey. 151, Broad Street, Birmingham; José Maria Vargas, 397, Kennington Road, S.E.; John Septibo Ward, 36, Oxford Street, Liverpool; Bartlett W. Winder, Sandon Terrace, Sheffield.

The following papers were read:—

73. "*Note on the Atomic Weight of Gold.*" By T. E. THORPE, F.R.S., and A. P. LAURIE.

In a former paper (*Trans.*, 1887, 565) the authors gave as their final result of twenty-five determinations of the atomic weight of gold the number 196·85, which differs by 0·21 from the value determined by Krüss. Krüss has sought to show, however, that this difference is probably due to the presence of free gold in the bromoaurate of potassium employed by the authors (*Berichte*, 1887, 2365). The authors reply that they were unable to detect any free gold in the salt used by them, and that they therefore altogether dissent from Krüss's conclusion that the lower value of 196·64 is to be preferred.

DISCUSSION.

The PRESIDENT inquired whether the authors had ever attempted to purify the gold by distillation. Stas had stated that it could be volatilised by means of the oxyhydrogen flame, and he had had occasion to confirm this observation—in fact, gold boiled violently when heated in a lime crucible by means of the oxyhydrogen blowpipe.

Prof. THORPE replied that no doubt the method suggested might be employed to purify gold. They had obtained their material from the Mint: the only impurity which might have been present was platinum, but it was improbable that it was, as a quantity which might escape detection by qualitative chemical tests appeared to be capable of rendering the gold brittle.

74. "*The Interaction of Zinc and Sulphuric Acid.*" By M. M. PATTISON MUIR and R. H. ADIE.

The experiments described are altogether qualitative. The authors have examined the interaction between sulphuric acid of varying concentration and zinc of different degrees of purity. If pure or nearly pure zinc and moderately dilute sulphuric acid interact at moderate temperatures, they give zinc sulphate and hydrogen only; as temperature and concentration increase the quantity of hydrogen produced decreases, and sulphur dioxide and sulphuretted hydrogen begin to appear. With concentrated acid and nearly pure zinc the chief gaseous product is sulphur dioxide. When commercial zinc is used sulphur dioxide and sulphuretted hydrogen are produced at almost all temperatures, and even with acids as dilute as—

$$H_2SO_4{\cdot}100H_2O.$$

Zinc sulphate is the only solid product of the interaction at any temperature or concentration of acid. The reaction with platinised zinc-foil resembles that with commercial zinc; in both cases sulphur is formed at moderately high temperatures when fairly concentrated acids are employed. Variations in the relative mass of zinc employed are without regular influence on the nature of the products of the change. The possible sources of the sulphur and the sulphur compounds are discussed in the light of the tabulated experimental results. The general conclusion is that the interaction between nearly pure zinc and sulphuric acid of different degrees of concentration is chiefly a direct chemical reaction; but that when less pure zinc is employed the reaction is largely electrolytic. The marked influence of concentration and temperature, in every case, makes it probable that the reactions are many and complex, and that they occur between zinc and various molecular aggregates of H_2SO_4 and H_2O, or of H_2SO_4, SO_3, and H_2O.

DISCUSSION.

In answer to Mr. Groves, Mr. MUIR said that they had not ascertained whether the sulphur which was produced was the soluble or the insoluble modification.

Replying to Mr. Harcourt he said that they had not attempted to take into direct account the influence of varying amounts of zinc sulphate; he thought, however, that if it had exercised any particular influence this would have been noticed in the course of the experiments, as the conditions had been very greatly varied.

Dr. ARMSTRONG expressed his surprise that the authors should have made in the beginning of their paper a halting confession that interactions such as that between sulphuric acid and zinc were "to some extent at least electrolytic;" and still more that they should state the opinion that their experiments afforded evidence that in the case of approximately pure zinc "chiefly direct chemical interaction" takes place. It was very remarkable that chemists did not recognise, as physicists had done, that the chemical and electrical phenomena were in such cases absolutely interdependent. The authors had brought forward a large amount of valuable information in their paper, but he could not conceive how any of their evidence could be interpreted as proof of direct chemical interaction—whatever that expression might mean.

In reply to Dr. Armstrong, Mr. MUIR stated that by the expression "direct chemical interaction," as compared with the expression used when speaking of the action between sulphuric acid and commercial zinc, viz., "a reaction partly chemical, and also to a large extent electrolytic," the authors meant that in one case zinc, sulphuric acid, and water interact in the manner usually called chemical, and that the products are either hydrogen and zinc sulphate, or, with a different concentration of the acid and a different temperature, hydrogen, zinc sulphate, and sulphur dioxide; while in the other case, besides this change, another occurs, viz., the decomposition of the acid by the electric current produced in the chemical reaction occurring between the acid, the zinc, and the other metal or metals in the specimen of zinc used. The first change might be, and probably was, electrical as well as chemical; but, if so, the generally used term, "chemical interaction," is here employed to include the electrical as well as the chemical part of the whole occurrence.

75. "*Note on Safety Taps.*" By W. A. SHENSTONE.

The author has previously pointed out ("Methods of Glass Working," pp. 64 to 66) that the safety taps recently introduced are open to the rather serious objection that they offer no special resistance to the passage of air in the direction in which leakage is most likely to occur, and that therefore such taps are only trustworthy when employed in conjunction with suitable mercury traps. But it had hitherto escaped his notice, and probably that of others also, that even when so protected these taps are still of unsatisfactory construction, as when the properly lubricated plug of the tap is brought into position the space below the plug remains full of air. If the tap be well made, nearly all this air will remain there during the exhaustion of any vessel that may be attached to either arm of the tap; but afterwards, especially if the lubrication of the tap becomes imperfect, air will gradually find its way from below the plug into any apparatus that may be attached to the tap.

To remove this imperfection a very simple alteration only is required, viz., that the plug shall be drilled so that when the tap is open there is free communication between the space below the plug and the contents of any apparatus of which the tap may form a part.

DISCUSSION.

The PRESIDENT exhibited and described two safety taps, the one sealed in one, the other in two directions, by mercury, which were not open to the objection raised by Mr. Shenstone.

Mr. SHENSTONE subsequently pointed out that the chance of leakage was very much reduced by placing the two arms of the tap at different levels and bringing them into communication by drilling a hole diagonally through the plug; and he particularly insisted on the importance of this modification of the ordinary method of construction.

76. "*Note on Guthrie's Compound of Amylene with Nitrogen Peroxide.*" By A. K. MILLER, Ph.D.

In the examination of the products of the manufacture of oil-gas (Armstrong and Miller, *Trans.*, 1886, 74) the want of a method of identifying different unsaturated hydrocarbons was keenly felt, and experiments in more than one direction are in progress which it is hoped may lead to a satisfactory solution of the difficulty of analysing complicated hydrocarbon mixtures of a similar nature. It appeared to be not improbable that nitrogen peroxide might prove a valuable reagent for the recognition of some of the constituents, as it was known to combine with certain unsaturated hydrocarbons to form well-defined crystalline derivatives; and it was further hoped that perhaps a reagent might be discovered which would characterise N_2O_4, and might be of surface in studying the vexed question of the existence of gaseous N_2O_3. It was conceivable that the formation of crystalline compounds depends on a particular molecular grouping of the carbon and hydrogen atoms, and that they will be producible from a homologous series of like constituted hydrocarbons only and not from their isomerides. A few preliminary experiments only have as yet been made, the work having been postponed from last winter owing to the great difficulty of working with such very volatile hydrocarbons and such comparatively unstable substances in hot weather. The reason for already bringing the subject before the Chemical Society is the recent publication of a paper by Wallach (*Annalen*, ccxli., 288), who has to some extent anticipated the author's line of work.

Many years ago, Guthrie (*Annalen*, cxix., 83) showed that when commercial amylene and nitrogen peroxide were brought together, combination took place, the products being a definite crystalline substance, $C_5H_{10}N_2O_4$, which decomposed sharply at 95°, and an oil. Although commercial amylene in known to consist chiefly of trimethylethylene, no proof had been given that Guthrie's compound is derived solely from this hydrocarbon, and not from some other constituent. This being a point of importance in connection with the research as indicated above, pure trimethylethylene was prepared from commercial amylene by agitation with sulphuric acid, &c., according to Wischnegradsky's method (*Annalen*, cxc., 328). The action of pure nitrogen peroxide on trimethylethylene and on the residual amylene was then separately examined. The trimethylethylene, dissolved in either carbon bisulphide or glacial acetic acid cooled by iced water, was converted almost entirely into Guthrie's crystalline compound; some green oil was also produced, but this crystallised for the most part on standing. On crystallising the product from benzene, prismatic crystals were obtained which decomposed sharply at 99°. No signs of the needles described by Wallach (*loc. cit.*) were observed.

On submitting a small portion of the residual amylene to the same treatment, no crystals were produced, and on pouring the product into water a separation into three layers was observed. The lowest layer consisted of a heavy oil which could not be made to crystallise by cooling to $-10°$ or by exposure to air. The uppermost layer was very volatile and consisted in all probability of pentane originally present in the amylene.

Experiments were also made with normal amylene and normal hexylene; these both yielded oily products heavier than water, and which also refused to crystallise.

From these results it would appear that trimethylethylene is the only constituent of commercial amylene which yields a crystalline derivative with nitrogen peroxide. It remains to be seen how the isomerides behave.

Discussion.

Professor Dunstan asked whether Dr. Miller had examined the action of reducing agents on Guthrie's compound. He suggested this as a test of the correctness of the formula proposed by Wallach, which represented the compound as a nitrosyl nitrate, a view which Victor Meyer had previously rejected because he obtained all the nitrogen in the form of ammonia on reducing with sodium amalgam. The action of ferrous hydroxide might decide the question, since nitrosyl, if present, would probably yield hyponitrite, while the nitroxyl, being unattacked by the weak reducing agent, would form amyl nitrate.

Dr. Miller replied that he had not.

77. "*The Dehydration of Metallic Hydroxides by Heat, with Special Reference to the Polymerisation of the Oxides and to the Periodic Law.*" By Professor Carnelley, D.Sc., and Dr. James Walker, University College, Dundee.

The object of this investigation was—*First*, to ascertain whether some light could be thrown on the question of the polymerisation of the metallic oxides (*cf.* Henry, *Phil. Mag.* [5], xx., 81) by heating certain hydrates at regularly increasing temperatures, and determining the degree of dehydration thus produced. In this way it seemed probable that data could be obtained for the construction of curves which would indicate whether any compounds were formed intermediate between the normal hydrates and the corresponding oxides, and thus give some information in regard to the general phenomena occurring during the dehydration, whilst the composition of those compounds, if formed, might also afford some clue to the true molecular weights of the oxides. *Second*, to determine the minimum temperature of complete dehydration of the metallic hydroxides with a view of ascertaining whether this temperature was a periodic function of the atomic weight of the positive element.

In the paper the methods of working and the full results are given, together with diagrams of curves in which these results are represented graphically. The general conclusions arrived at are as follows:—

1. Precipitated antimony trioxide is anhydrous. On heating it underwent the following changes: Sb_2O_3 or $Sb_{20}O_{30}$ stable up to 360°; then rapid absorption of oxygen with formation of $Sb_{20}O_{32}$ (?); the latter comparatively stable to 415—440°; then further absorption of oxygen with formation of $Sb_{20}O_{35}$ (?); the latter comparatively stable to 500—565°; third absorption of oxygen with formation of Sb_2O_4 or $Sb_{20}O_{40}$; the latter stable from 590° to above 775°.

2. The following definite stable hydrates appear to exist:—

(*a.*) $AgOH$, stable up to about 100°, then rapid loss of water with formation of Ag_2O; the latter stable to 180—270°, then reduction to metallic silver; this reduction complete at 300—340°.

(*b.*) $Hg(OH)_2$, stable up to about 100°; complete dehydration to HgO at about 175°, when incipient decomposition into Hg and O_2 commences, followed by full decomposition at about 415° to 440°.

(*c.*) $CeO_2{\cdot}2H_2O$ or $Ce(OH)_4$ = ortho-ceric hydrate. This hydrate was formed on heating precipitated hydrate of cerium dioxide to about 385°. It remained stable from about 385° to 600°. It was of a light yellow colour. On heating to over 600°, it underwent dehydration to CeO_2, and became salmon coloured. This is the only definite stable hydrate of the oxides RO_2 of the silicon-titanium group obtained. In other respects cerium hydrate on dehydration behaved like the hydrates referred to in § 5.

(*d.*) $5Co_2O_3{\cdot}8H_2O$.—This was the composition of air-dried cobaltic hydrate, and was perfectly stable up to 75°.

3. The following data in regard to the action of heat on the hydrate of Pb_2O will possibly be of interest in the manufacture of red lead:—Hydrate dried in air = $3PbO_2{\cdot}H_2O$; complete dehydration about 230°; PbO_2 stable up to about 280°; loss of oxygen with formation of Pb_2O_3 at 280—290°; Pb_2O_3 stable at 290—360°; loss of oxygen with formation of Pb_3O_4 at 360—415°; Pb_3O_4 stable at 415—530°; loss of oxygen with formation of PbO at 530—580°; PbO stable from 580° to above 815°; PbO fused somewhere between 585° and 630°.

4. Air-dried thallic hydrate = $Tl_2O_3{\cdot}H_2O$, but unstable on heating; complete dehydration to Tl_2O_3 at about 230°; Tl_2O_3 perfectly stable at 230—360°; reduction to $3Tl_2O_3{\cdot}Tl_2O$ at 360—440°; $3Tl_2O_3{\cdot}Tl_2O$ perfectly stable at 440—565°; rapid loss of oxygen and volatilisation of Tl_2O formed at 585—815°; the rate of loss gradually diminishing after fusion at 630°; remaining Tl_2O_3 constant from 815° upwards.

5. An examination of all the results shows that, with the exceptions referred to in § 2, there was no certain indication of the formation of definite hydrates, which were stable through any but possibly a small range of temperature. From this we must conclude, either that there are no definite hydrates formed on heating at gradually increasing temperatures, or that a very large number of such hydrates are produced under these conditions, but are so unstable that a further rise in temperature is sufficient to convert a higher into a lower hydrate. Of these, the second alternative is, for reasons given, by far the more probable.

The results accord entirely with Professor Henry's theory that the known metallic oxides are polymers $n(RO_x)$ of the unknown simple oxides (RO_x). The results also show that in most cases, especially those of SiO_2, TiO_2, SnO_2, Al_2O_3, &c., the coefficient n of polymerisation must be very large, as might be expected from the infusible character of these oxides. Minimum values for this coefficient are indicated in some cases.

6. The retention of water by many oxides at comparatively high temperatures, at and above a red heat, is noteworthy. This is especially interesting in the case of the hydrate $Ce(OH)_4$, which is stable to so high a temperature as 600°. The retention of water at such high temperatures illustrates the great importance in quantitative analysis of the thorough ignition of hydrates before weighing.

7. The minimum temperature of complete dehydration is a periodic function of the atomic weight, as follows:—

(*a.*) *For normal oxides of odd members of the same group, the minimum temperature of complete dehydration diminishes as the atomic weight of the positive element increases.*

(*b.*) *For even members of the same group it increases as the atomic weight of the positive element increases.*

(*c.*) *For normal oxides of elements belonging to the same period the minimum temperature of complete dehydration diminishes from the beginning to the middle, and then increases to the end of the period.*

These results accord with the heats of combination of the normal oxides with water in the formation of hydrates.

8. Of two oxides belonging to the same group, the one which requires the highest temperature for complete dehydration will usually combine at any other lower temperature with a greater quantity of water per molecule of oxide, though this is not always the case, the pairs SiO_2, SnO_2, and Al_2O_3, In_2O_3 being marked exceptions. From this we may conclude that the order of affinity of the oxides for water is *usually* the same both in *intension* and in *extension*, though not always so.

2. Changes of colour on dehydration which are *permanent on cooling* usually indicate the formation of a definite hydrate, or that the dehydration is complete, or that some other definite chemical change has occurred.

78. "*The Bromination of Naphthalene β-Sulphonic Acid.*" By G. Stallard.

The author has revised and extended the work of Darmstädter and Wichelhaus (*Annalen*, clii., 303) and

Jolin (*Nova Acta Soc. Upsal.*, 1877). He finds that when a strong solution of $C_{10}H_7 \cdot SO_3K(\beta)$ is acted upon by 1 mol. prop. of bromine, a mixture of mono- and dibromo-salt is precipitated, consisting chiefly of the former. Their separation is best effected by fractional crystallisation of the copper salts: the mono-salt separates out first in the form of very small pale green rhombic plates, while the dibromo-salt remains in the mother-liquor, and eventually comes down from a sufficiently concentrated solution in the form of long, sage-green, seaweed-like filaments. The mono-salts examined are the potassium (anhydrous), barium ($+H_2O$), calcium ($+H_2O$), and sodium ($+H_2O$)—which all crystallise in colourless needles—and the copper salt ($+8H_2O$). The dibromo-salts examined are the potassium ($+\frac{1}{2}H_2O$), barium ($+3\frac{1}{2}H_2O$), calcium ($+2H_2O$), and sodium ($+H_2O$)—which were all obtained in colourless needles—and the zinc salt ($+9\frac{1}{2}H_2O$), which separated from solution in the form of a slightly opalescent, almost translucent jelly, and the copper salt ($+7H_2O$).

The constitution of these bodies is shown by the fact that the monobromo-salts yield on hydrolysis α-bromonaphthalene, while the dibromo-salts give the so-called β-dibromonaphthalene, which is the $\alpha'\alpha^4$ modification. Hence the tribromonaphthalene (m. p. 86·5°) which Jolin prepared from the dibromo-sodium salt by the action of PBr_5, is either the $\alpha'\beta^2\alpha^4$ or the $\alpha'\beta^{2'}\alpha^4$ modification. The first of these formulæ, however, is inadmissible, since it has been already assigned with good reason to Meldola's tribromonaphthalene of m. p. 114° (*Chem. Soc. Trans.*, 1883, 4) from dibromo-α-naphthylamine, and hence the constitution of the mono- and dibromo-sulphonic acids above-mentioned must be $Br : SO_3H = 1-2'$ and $Br : Br : SO_3H = 1 : 4-2'$.

Further experiments to test the correctness of this conclusion are in progress. The monobrom-acid appears to correspond to the chloro-sulphonic acid which Cleve has recently (*Berichte*, 1887, 72) obtained from nitronaphthalene-β-sulphonic acid.

79. "*The Constitution of the three Isomeric Pyrocresols.*" By W. BOTT, Ph.D.

By reducing α-pyrocresol by means of hydrogen iodide the author has obtained, among other products, a hydrocarbon having the properties of a paraffin. and approximately of the composition $C_{15}H_{32}$; zinc-dust appears to reduce pyrocresol in a similar manner—but with difficulty. Attempts to displace the oxygen in pyrocresol by chlorine by means of phosphorus pentachloride were attended with little success—all attempts to purify the product having failed. From these results and those previously obtained by Schwarz and himself, the author draws the conclusion that the pyrocresols are compounds of the type of phenyl ether.

DISCUSSION.

In reply to Dr. Armstrong, who asked why so peculiarly unfortunate a name as "pyrocresols" had been assigned to compounds which were neutral substances and not "ols," *i.e.*, phenols, and could not possibly bear any simple relation to the cresols, Dr. BOTT said that he was not responsible for the name; it was selected by Schwarz because they were by-products of the manufacture of cresols and their homologues, and were obtained when the retorts in which distillation was effected became overheated.

80. "*Preliminary Note on Certain Products from Teak.*" By R. ROMANIS.

The author finds that alcohol extracts a soft resin from teak, but no oil or varnish. On distilling the resin he obtained a crystalline substance which he also found to be present in considerable quantity in the tar resulting from the destructive distillation of teak. The analyses which he has made for the crystals point to the empirical formula C_9H_8O; on oxidation with nitric acid they yield what appears to be a quinone of the formula $C_{18}H_{16}O_2$.

At the next meeting, on November 17th, there will be a ballot for the election of Fellows, and the following paper will be read:—

"Zinc-copper and Tin-copper Alloys," by A. P. Laurie.

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

SIR,—My letter which appeared in the CHEMICAL NEWS (vol. lvi., p. 168) was somewhat hurriedly written, and as Chateau's work was not at hand I simply referred to Fontenelle. Mr. Allen's letter, which appeared in reply to this, confirms my belief in the statement which I made, and which has opened up this correspondence.

I propose to answer Mr. Allen's letter (vol lvi., p. 188) more fully. I must first point out that by "practical acquaintance" I mean experience in using. One may know of a test, but, if another method for doing the same thing has been worked up, no one is justified in giving it up unless something is gained. Hausemann's method differs from what I use entirely, and although it is a reaction which recognises an acid it can be made quantitative. I have no difficulty with it; it is applicable to any oil, fat, or resin which I have met with for quantitative results.

Hehner's method of examining butter, and Reichert's method of determining volatile fatty acids, I have not had occasion to use myself; but Mr. Edwin Bruce Warren is working on these methods, in connection with butter adulterations, in my private laboratory.

Gladding's process for separating fatty and resin acids I know, but do not use, as I effect the same thing in another way. Fontenelle (p. 415) gives a method, which he speaks highly of, for separating resin and rosin oils.

The improved methods of determining specific gravities, &c.: I recognise here a method which at first I could not identify as the "tin pot concern," which I have always called Laurot's Oleometer, and which consists essentially of a tin vessel for containing the oil, which is placed in another tin vessel serving as a water-bath. I use this for determining the specific gravities of tallow, palm oil, and cocoa-nut oil, or any viscous oil; in fact, in winter it is generally used. For waggon-grease and similar lubricants I use an ordinary glue-pot. If we substitute a glass beaker, or tube, for the inner pot, we get what Mr. Allen refers to. A description of Laurot's Oleometer will be found in Chateau.

Because I suggested the elimination of air-bubbles, &c., Mr. Allen says that I am "not acquainted with their real object or character." I presume Mr. Allen means expansion coefficients. Does he know that Saussure did a great deal this way, and that his results are scattered under the principal oils in Chateau's work?

It will be necessary here to say a few words on the "antiquated works of Chateau and Fontenelle." Fontenelle was, I should fancy, an engineer, and from what I know I suppose that there is scarcely an oil-works in the United Kingdom, in Europe, or America, which is not indebted more or less to Fontenelle's drawings of machinery, description of processes, &c.

Chateau:—About 1862 La Société Industrielle de Mulhouse offered a premium for a method for analysing oils. Chateau gained the prize. Amongst other tests which he subsequently gave was the saponification method and iodine absorption. ("Chateau Essais Personnels," p. 70; see also "Chlore, Brôme, et l'Iode," p. 16.

Mr. Allen wants figures for six oils before he will believe this. It is certainly very singular that Chateau gives no figures of results, nor particulars; still any chemist could carry out these tests even from the little that is said.

The bromine process is due to Cailletet (Chateau, p. 66). It is also remarkable that only one experimental result is given. Chateau says that the idea is excellent, and suggests making the process volumetric (Chateau, p. 70).

The separation of fatty acids, resins, and hydrocarbon oils: I make a practice of examining every sample of oil which comes in my way, and which may be included in this. I may say that when Fontenelle and Chateau wrote the hydrocarbon oils were far off the important position they now occupy.

Mr. Allen says that I think "the chemists who have devised methods of determining glycerin deserve no recognition of their labours. I simply contradict this assumption. Mr. Allen "challenges Mr. Warren to show that Chevreul indicated any such thing; but if he did," &c. It is a pity Mr. Allen cannot be logical; either Chevreul did what I say or he did not. Will Mr. Allen say that fixity of composition is a myth?

Mr. Allen seems to think that smart remarks are as good as argument. I wish to say that they do not add to the dignity of a scientific discussion, even when they are showered by a man in Mr. Allen's position upon one like myself. I have no interest in oils whatever; I have simply taken their study up, *inter alia*, as a pastime amusement: still I should be sorry if I had to admit that Mr. Allen was my intellectual superior in this matter.

Mr. Allen's ten methods show how little we have to boast about for twenty-one years. Is it not a fact that consumers of oil are more disgracefully imposed upon now than they have ever been before? Omitting those relating to butter, the remaining eight methods have done no very important part in protecting a consumer.

I omitted to mention in the proper place that Chateau's "antiquated" work is given in the list published, about a month ago, as a work of reference for the technical examination in oils, by the City and Guilds of London Institute. I am so far impressed with the usefulness of this book that I have applied for permission to translate the same. I am waiting for a reply.

Accompanying this letter are extracts from Chateau and Fontenelle which Mr. Allen has asked for, and which are referred to in this letter.—I am, &c.,

THOMAS T. P. BRUCE WARREN.
Tamworth Villa, Earlham Grove,
Forest Gate.

[We have sent the extracts from Chateau and Fontenelle to Mr. Allen. The discussion, having ceased to be of general scientific interest, must now close.—ED. *C. N.*]

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 17, October 24, 1887.

On the Congelation of Ciders.—G. Lechartier.—Congelation at −18°, and maintained for 212 hours, did not sterilise worts and ciders in different stages of fermentation, although the fermentation was enfeebled. The application of a temperature of −18° to −20° does not give a saccharine solution containing ferments the property of resisting further transformations if subsequently exposed to ordinary temperatures.

Action of Hydrogen Sulphide upon the Salts of Cobalt.— H. Baubigny.—The author showed some years ago that all the salts of nickel are converted into sulphides if their solutions are treated with hydrogen sulphide at the ordinary temperature, and if heated even in an acid liquid. On studying the salts of cobalt in the same manner he has arrived at similar results, the only sensible difference between the two metals consisting in the less or greater readiness with which their salts are converted into sulphides. The appearance of the sulphide is much more rapid in the solution of a neutral salt of cobalt than in the corresponding salt of nickel, all things being equal. In cold, acetic acid can completely annul the action of hydrogen sulphide upon both cobalt and nickel sulphates.

Determination of Titanic Acid.—Lucien Lévy.—In certain cases the ordinary method gives good results, but according as more or less sulphuric acid has been volatilised, and as the substance is more or less rich in bases, considerable errors may be produced. The liquid should first be completely neutralised, and the required quantity of sulphuric acid (0·5 per cent) should then be added. After fusing the sample with bisulphate the solution of the melted mass is always slow. It may be hastened by adding sulphuric acid enough to convert all the potassa into the state of bisulphate. When the whole is dissolved the author adds 0·5 per cent of free sulphuric acid, boils for six hours, collects, washes, ignites, and weighs the titanic acid.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., August, 1887.

Analysis of Commercial Manures.—From the *Proceedings of the Association of Agricultural Chemists* at Washington. Given in the CHEMICAL NEWS for October 29, 1886.

Manufacture of Methyl Violet (Paris Violet).—Dr. Otto Muhlhauser.—A full account of the manufacture of this colouring-matter by the recent phenol process.

Manufacture of the Orangés.—Dr. Otto Muhlhauser.—An account of the preparation of sulphanilic acid, of orangés II., I., RR, and R.

Chemical Composition of Herderite and Beryl.—S. Penfield and D. Harper.—Translated from the CHEMICAL NEWS.

Manufacture of Potassium Chlorate on the Magnesium Process.—By Longuet Higgins.—From the *Journal of the Society of Chemical Industry.*

On a Fundamental Law of Thermo-Chemistry.—Clarence A. Seyler.—Translated from the CHEMICAL NEWS.

On a Fundamental Law of Thermo-Chemistry.—A. Seyler and S. Pickering.—Translations of two letters addressed to the CHEMICAL NEWS.

Contributions to the Assay of Quinine.—O. Hesse.—From the *Pharmaceut. Zeiting.* This important paper does not admit of useful abstraction.

On Varnish Resins.—P. L. Simmonds.—From the *Journal of the Society of Arts.*

Industrial Review and Patents taken at Berlin.—Process for preparing barium carbonate from the sulphate by means of sugar or treacle. Dr. Wackenroder. W, No. 4513.

Process for preparing and separating a new *a*-naphthylamine-disulphonic acid. Dahl and Co., of Barmen. D, No. 2748.

Preparation of naphthol-trisulphonic acids, and of dioxy-naphthaline-disulphonic acid. F. Bayer and Co. F., No. 3046.

Preparation of quinoleine-parasulphonic acid. Baden Aniline Co. B, No. 7469.

Azo-colouring-matters derived from tetrazo-diphenyl-dicarbonic acid, or from its methylic or ethylic ethers. Dr. L. Paul. P., No. 3052.

Preparation of acetone. H. de Grousilliers. G, No. 4012.

Preparation of substituted naphthylene diamines; colouring-matters obtained with these combinations and with the nitroso-derivatives of the tertiary aromatic amines. Durand and Huguenin. D, No. 2764.

Preparation of brown colouring-matters by the action of nitrous acids or the nitrites upon the phenol-monosulphonic acids. H. J. Walder. W, No. 4596.

Preparation of acetyl or benzoyl chlorides by means of benzyl acetate or ethyl benzoate. Dr. E. Sellig. S, No. 3627.

Transformation of the pigment of santal-wood and other woods containing santaline into a soluble colouring-matter. Dr. Alb. Zander, Z. No. 843.

Oxy-azo colouring-matters obtained by combining diazo-amido-derivatives with phenols or phenol-sulphonic acids. B. Fischer and H. Michaelis. M., No. 4835.

Colouring-matters prepared with naphthylamine-disulphonic acid III. Dahl and Co. D, No. 2772.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Manufacture of Oxygen.—I have seen an article about the Brin process of manufacturing oxygen. Can you give me the address of the firm, or insert a question to that effect?—F.C.S.

MEETINGS FOR THE WEEK.

THURSDAY, 17th.—The Parkes Museum of Hygiene, 5. "The Importance of Open Spaces," by the Rt. Hon. the Earl of Meath.

— Chemical, 8. "On the Halogen Substituted Derivatives of Benzalmalonic Acid," by Chas. M. Stuart, M.A.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1460.

ON THE CONSTITUTION OF BASIC SALTS.

By SPENCER U. PICKERING, M.A.,
Professor of Chemistry at Bedford College.

I have previously drawn attention to certain analogies between basic and hydrated salts, and have attempted to explain these analogies on the theory of residual affinity (Chemical News, lii., 240, and liv., 216; *Chem. Soc. Proc.*, 1885, 122; and pamphlet on "Atomic Valency," p. 5).

The analogy goes further, I believe, than in the existence of definite basic salts comparable with definite hydrated salts. The solution of a salt contains, according to my views, hydrates of a higher order and more complicated than those which are generally known to exist in the solid state, and which, owing to their complexity and to their being always more or less dissociated, generally appear under our imperfect methods of investigation to be indefinite in composition, and to vary continuously with a variation in the physical conditions of the liquid (Chemical News, liv., 216). Anyone who has investigated basic salts must have been struck with the fact that, besides the existence of perfectly definite compounds, we also have basic compounds which are apparently indefinite in composition, but which we cannot accept as mere mixtures, and which, according to my views, are precisely analogous to the complex hydrates constituting a solution of a salt in water.

It was with the object of obtaining positive proof that the basic salts of variable composition are not mere mixtures, but are actual compounds, that the present investigation was undertaken. The results, as far as they go, are in favour of this view, but they are not sufficiently pronounced to afford a proof of it, and I venture to give them only in outline, more as an indication of the direction in which light on this subject might be obtained than as evidence for or against my views.

The definite basic sulphates of copper, though more numerous than those of iron or aluminium, are, as far as we know at present, only three in number (Chemical News, xlv., 121, and xlvii., 181; *Chem. Soc. Trans.*, 1880, 807). Their formulæ are $6CuO,2SO_3,5H_2O$, containing 74·787 per cent of CuO on the anhydrous substance, and $4CuO,SO_3,4H_2O$, containing 79·798 per cent CuO.*

When an ammoniacal solution of copper sulphate is diluted with water there is at first precipitated a violet-blue basic salt, having the composition—

$$4CuO,SO_3,2NH_3,5H_2O,$$

which in the proportion of CuO to SO_3 is 79·818 to 20·192 (*Chem. Soc. Trans.*, 1883, 336). With a larger amount of water the proportion of this basic ammoniacal sulphate decreases, and the precipitate finally contains no ammonia, and in appearance is totally different from the ammoniacal one, being light blue and flocculent, and easily distinguishable from any particles of the ammoniacal sulphate which may have come down with it. As the proportion of water is still further increased the precipitate becomes darker, more bulky, and at the same time more basic, the limits of basicity reached in any of my experiments being 94·4 per cent, reckoned on the anhydrous salt, a percentage which would correspond to the composition $17CuO,SO_3$. As this precipitate is already highly basic, and as, no doubt, still more basic ones might be obtained by using a larger proportion of water, it is reasonable to conclude that, if the precipitates are mixtures at all, they are mixtures of a basic sulphate with copper hydrate itself, and not mixtures of a less basic sulphate with a very highly basic one, the most basic definite sulphate known being only $4CuO,SO_3$.

The question to be answered, then, was—Can these precipitates be proved to contain, or not to contain, free copper hydrate? The answer was sought as follows:—Various precipitates of different basicity were prepared, and, after being dried under precisely similar conditions, were analysed. Now, if the higher basicity of one precipitate over another is due to the presence of excess of free copper hydrate, then, by subtracting the weights of the various constituents of the less basic one from those of the more basic one, we shall obtain the weight and composition of the copper hydrate ($xCuO+yH_2O$) which the second precipitate has in excess of the first, and so on with the other still more basic precipitates; and if the composition of this copper hydrate is found to be constant throughout the series, it may well be concluded that it is in reality excess of this same substance which causes the increase in basicity, whereas, if the composition of the copper hydrate thus calculated is different in each case, the hypothesis that the increased basicity is due to admixture of excess of this same substance (the copper hydrate) becomes untenable.

The experiments were complicated by the facts that the basic precipitates are very bulky and difficult to wash, that they are slowly decomposed by water, that they absorb carbon dioxide very readily, and that they take a very long time in becoming anhydrous. A series of experiments performed in 1882 were rendered useless by the absorption of carbon dioxide, the precipitates having been allowed to dry in the air.

In the present series the temperature of the water used for the dilution was 14·6, the liquid after twenty-four hours was syphoned off, and the precipitates were washed in a centrifugal wire-gauze drum lined with filter-paper; they were then dried *in vacuo* on porous tiles, and subsequently powdered and exposed each in two separate watch-glasses *in vacuo* till constant in weight, each watch-glass containing about 1 grm. As the drying occupied some months considerable variations in the temperature occurred, but, by removing the duplicate watch-glasses at different periods, it was found that these variations had no effect on the composition of the substance.

Although many precautions were adopted to exclude carbon dioxide during the sundry operations, a certain amount was nevertheless absorbed, and this was determined by distillation with acid *in vacuo* and measuring the gas evolved. It amounted to 0·96 to 2·3 per cent in the various cases, and a correction was applied to the analyses assuming that its absorption took place according to the equation—

$$xCuO,SO_3,yH_2O+zCO_2=z(2CuO,CO_2,2H_2O)+ +H_2SO_4+y-(2z+1)H_2O,$$

it having been established by a separate experiment that copper carbonate prepared in the same way possessed the composition $2CuO,CO_2,2H_2O$ when dried *in vacuo*.

In the case of the less basic precipitates the ammonia present was determined before the carbon dioxide by boiling *in vacuo* with potash, and Nesslerising the ammonia evolved: the precipitates 2 and 3 alone contained any appreciable quantity; it amounted to 0·37 and 0·15 per cent in the two cases respectively. The sulphuric acid and copper oxide were determined gravimetrically, dividing the contents of each watch-glass into two or three portions for this purpose. This part of the analytical work was conducted by Mr. P. G. Sanford.

The final mean results obtained are given in the accompanying table, calculated to show the various amounts of CuO and H_2O present with a uniform weight—0·1 grm.—of SO_3. The individual analyses and duplicate experiments were all very fairly concordant, but it will be seen there is a want of uniformity in these final results.

* These formulæ apply to the salts when dried in air or *in vacuo*. At a high temperature Shenstone obtained the salt $6CuO,2SO_3,4H_2O$ (*Chem. Soc. Trans.*, 1885, 375).

The basicity of the precipitate increases generally with the proportion of water used for the precipitation, but those two which contained ammonia—Nos. 2 and 3—are exceptions to this rule; so also is No. 5, which approaches so nearly in composition to No. 6 that I have combined these two experiments in one mean.

Composition of the Precipitate obtained.

Molecules of water added to 1 molecule CuO in the sol. taken.	SO_3.	CuO.	H_2O.	Total.	$\frac{CuO}{CuO+SO_3}$.
1. 2,360	0·1	0·6733	0·2454	1·0187	87·067
2. 1,590	0·1	0·7353	0·1917	1·0270	88·025
3. 1,380	0·1	0·7760	0·2155	1·0915	88·584
4. 14,300	0·1	0·8821	0·2883	1·2704	89·812
5. 4,800	0·1	0·9585	0·3027	1·3612	90·550
6. 19,050	0·1	0·9536	0·2910	1·3446	90·507
Mean of 5 & 6	0·1	0·9561	0·2968	1·3529	90·528
7. 38,050	0·1	0·9955	0·3358	1·4261	90·831

Now, subtracting the weights of the various constituents of one precipitate from those of that next to it in basicity, we get—

Experiment.	CuO.	H_2O.	$\frac{H_2O}{CuO+H_2O}$.
4—1	0·2088	0·0429	17
5 and 6—4	0·074	0·0085	11
7—5 and 6	0·394	0·039	50

and, including those precipitates which contained admixed ammonio-sulphate,—

3—2	0·0407	0·0238	37
4—3	0·1061	0·0628	37

Thus in all cases except one—namely Expt. 1 as compared with 2—an increase in the amount of copper oxide is accompanied by an increase in that of the water. But the numbers certainly do not tend to show that there is any definite relationship between the excess of copper oxide and water such as would exist if the increased basicity were due to the admixture of varying amounts of copper hydrate; at the same time it cannot be pretended that the results are sufficiently numerous, regular, or concordant to give a satisfactory denial to such a view.

It must be remarked, however, that the proportion of water to copper oxide — 50 per cent representing $CuO,4{\cdot}4H_2O$, and 37 per cent representing $CuO,2{\cdot}6H_2O$— is considerably in excess of that retained by copper hydrate *in vacuo*, which certainly does not exceed $2H_2O$ and is probably not more than H_2O, and renders it improbable that the copper oxide is present in this form. The appearance and behaviour of the precipitates are also not favourable to the hypothesis of their containing free copper hydrate, since the less basic ones are rather compact, of a light opaque blue colour, and can be washed and dried without the slightest blackening, while their behaviour with carbon dioxide does not favour the supposition of their containing any of the known definite basic sulphates: these latter are attacked but slowly by the gas, whereas the precipitates in question are very easily attacked; thus in one experiment it was found that only 1-30th of some $4CuO,SO_3,2H_2O$, precipitated by potash, had been converted in twenty-four hours into carbonate by the passage of a current of carbon dioxide through water in which it had been suspended, whereas an equal weight of a precipitate corresponding in composition to No. 4 in the above table had, after similar treatment, been converted into carbonate to the extent of 80 per cent.

Nickel Mordants; their Use in Calico-printing and Dyeing.—L. Liechti and G. Ulrich (from *Chemische Industrie*).—The use of nickel mordants is recommended when it is desired to produce light but fast tones.

IODIDE OF STARCH.

By H. B. STOCKS.

Besides the ordinary method of formation (*i.e.*, by adding a solution of iodine to starch paste) iodide of starch is gradually formed when dry starch and an alcoholic solution of iodine are triturated in a mortar, provided the alcohol contains water. With absolute alcohol a brown colour is produced which, on the addition of water, changes to blue; it appears, therefore, that water is necessary to the formation of iodide of starch.

Iodide of starch is not formed when iodine vapour is passed over dry starch, but by using moist starch the iodide is formed; this also seems to show that water is necessary for the formation of this body.

It is formed by the action of various reagents on a mixture of potassium iodide and starch paste; the reagents are those which liberate iodine from its compounds—chlorine, bromine, nitric acid, strong sulphuric acid, ferric chloride, ozone (Schönbein), potassium permanganate—potassium bichromate, &c., produce the blue colour.

The blue colour produced by chlorine and by bromine is destroyed by excess of the reagents; excess of nitric acid or of sulphuric acid also destroys the compound.

In a paper by F. Mylius (*Ber.*, xx., 688, abstracted in *Journal Soc. Chem. Industry*) it is stated that the author has found that the formation of blue iodide of starch is not due to iodine alone, but also to the simultaneous action of hydriodic acid or an iodine salt. After reviewing the experiments that have been done, and repeating those of the author, I come to the conclusion that this is not the case. The statements made by Mylius are (1) That a solution of iodine in water does not give a blue colour with starch; this is manifestly incorrect, because iodide of starch is formed under these circumstances. (2) That "all the iodine solutions which colour starch blue contain hydriodic acid or an iodine salt." This may be answered in the same way, iodide of starch being formed when a solution of pure iodine is mixed with starch paste, or when iodine vapour is passed over moist starch. (3) "If a compound be present which destroys hydriodic acid—*e.g.*, chlorine—no blue iodine starch is formed." With regard to this statement Miller says that chlorine destroys iodide of starch owing to the formation of chloride of iodine. This I think much more correct than the above. The real fact is that a limited amount of chlorine, added to a mixture of hydriodic acid or an iodide and starch paste, colours it blue, owing to liberation of iodine, but excess of chlorine destroys the colour. It may be that chlorine takes the place of iodine in the compound with starch, as a compound with bromine is known. (4) "A silver solution decolourises iodine starch; on the addition of iodine, the mixture becomes yellow, but hydriodic acid or one of its salts restores the blue colour." Repeating this experiment it was found that on adding silver nitrate to a solution of iodide of starch, the blue was destroyed, with formation of iodide of silver; on adding excess of iodine to this the blue was reformed: if, however, without adding more iodine, hydriodic acid or one of its salts certainly produced a blue colour; but this is simply explained when we take into account the action of nitric acid. I have not been able to find in books to which I have access what action iodine has on a solution of silver nitrate, but I believe that a portion of nitric acid is liberated, and this acts on hydriodic acid or its salt, liberating iodine, and thus we get the blue colour.

I have stated the above in a concise manner, so as to show upon what grounds Mylius bases his idea that hydriodic acid or an iodine salt is necessary to the formation of iodide of starch.

Iodide of starch is soluble in a large quantity of pure water. As ordinarily prepared, it is an opaque blue mass, and when examined under the microscope is seen to consist of blue flocculent masses of the iodide floating in a liquid portion.

This shows that the idea of Liebig and others, that the colour of iodide of starch was due to the starch granules being mechanically coloured by iodine being deposited on their surface, was not correct, as in the above case the granules were entirely broken up.

On examining starch granules coloured by iodine, it appeared as if the whole of the interior of each granule were coloured; the iodine evidently has penetrated through the coating of starch cellulose into the inner portion which consists of real starch.

The chief peculiarity of iodide of starch is the readiness with which the colour is destroyed by heat; the change is gradual, the liquid becoming first greenish, then yellowish, and finally colourless. If, after boiling the iodide of starch until colourless, it be allowed to cool, the blue is not re-formed. Pellétier states that the blue colour is re-formed on cooling provided all the iodine has not been driven off by the boiling. If the heating is stopped at the yellowish stage, and the liquid allowed to cool, the blue is re formed to a slight extent, more so if only the greenish stage has been reached, but neither regain the original intensity of colour, showing loss of iodine. During the heating the smell of iodine was noticed in the escaping vapour.

With regard to the decolourisation of iodide of starch by heat, Baudrimont says that it is due to the volatilisation of the iodine, and states that it does not occur in sealed tubes, when concentrated iodide of starch is used, or when the liquid contains excess of iodine. He also states that dilute iodide of starch, heated in a sealed tube thirty or forty times was decolourised each time, and regained its blue colour on cooling. Kraut states that iodide of starch becomes colourless when heated in a sealed tube for some hours.

It was found that a solution of iodide of starch, when heated in a sealed tube, became colourless in an hour, and did not regain its blue colour on cooling; a solution containing much more iodine than the last required three days heating before it was decolourised, and it remained colourless on cooling. It is evident, therefore, that when iodide of starch is decolourised by heat, iodine is not necessarily volatilised, as stated by Baudrimont, and that his solutions were not heated long enough, or they would have been decolourised. Langlois states the same, that a concentrated solution of iodide of starch was not decolourised on boiling. The same remark may be applied here, namely, that the solution was not heated long enough, or it would have become colourless, as a very strong solution I tried, though requiring much boiling, eventually became colourless.

The decolourised iodide still contains iodine in some form. It seems then that the iodine goes into combination as some colourless body, as no free iodine is present in the boiled solution; this is evidently the case, as blues containing much iodine take a longer time to decolourise than those only containing a small quantity, or, in other words, time is required for the decomposition of the iodide of starch and formation of the new body. This is stated to be hydriodic acid by Kraut; Pelletier and Fritzsche say it contains no free hydriodic acid; Langlois says it contains iodic acid My experiments confirm those of Kraut. The starch is apparently not altered, for on adding more iodine to the decolourised liquid the blue was again formed, and this decolourisation and recolouration may be continued a number of times without any effect upon the starch. In open vessels only part of the iodine is converted into hydriodic acid, the rest being volatilised; in sealed tubes, however, all the iodine is converted into hydriodic acid.

If we now refer to the trituration of an alcoholic solution of iodine with dry starch, we shall find that the iodide was not formed; this is mentioned by Pohl, who says that the alcohol overcomes the attraction of starch for iodine, but on adding water the iodide is formed, owing to its weakening the effect of the alcohol.

If absolute alcohol be added to a solution of iodide of starch it is thrown out of solution, but the alcohol has no action upon it. I think, therefore, that the reason why iodide of starch was not formed in the above case is because of the absence of water, which seems to be necessary to its formation (see action of other reagents below).

With regard to the action of other reagents on iodide of starch. Sunlight decolourises it, as stated by Raspail, Guibort, and by Payen; a tube of iodide I exposed to diffused sunlight required about nine months to decolourise it. I expect the action of sunlight is similar to that of heat, only much slower, but have not yet examined the product, as my first tube was destroyed; however, I have another experiment in progress with a parallel tube kept in darkness.

Iodide of starch is precipitated from its solution by dilute hydrochloric, sulphuric, and nitric acids, strong hydrochloric acid, and by solutions of salts which do not act upon it, such as sodium chloride, barium chloride, &c.

Starch solutions are not precipitated by dilute acids as the iodide is. Strong nitric acid and strong sulphuric acid decompose the iodide.

Acetic acid does not precipitate the blue compound.

The blue compound is destroyed by chlorine (Henry and Humbert), by bromine (as before stated), by sulphurous acid, by hydrosulphuric acid (Langlois), arsenious acid (Pisani), alkalies, &c. According to Pisani the blue is destroyed by trichloride of antimony, chloride of arsenic, auric chloride, ferrous, manganous, mercurous, mercuric, and silver salts.

It is stated by Payen and Langlois that alcohol and ether abstract a part of the iodine from iodide of starch, but I did not find this to be the case, unless an excess of iodine is present, as a solution of iodide of starch treated with ether gave iodine up at first, but on repeated treatment with ether it still remained blue, but gave no iodine. A solution treated with alcohol gave up no iodine.

Starch has, therefore, more affinity for iodine than has alcohol or ether, or any other solvent for iodine I have yet tried. A solution of iodine in carbon bisulphide or benzene, when treated with starch paste, lost all its iodine, it combining with the starch; and oppositely carbon bisulphide or benzene do not extract any iodine from iodide of starch, when it contains no excess of iodine.

Therefore I think we are justified in regarding iodide of starch as a compound, or probably more than one compound of starch with iodine, water also being taken into account, and refer its decolourisation by heat to the fact that the iodine contained in it is converted into hydriodic acid.

Many analyses have been made of iodide of starch and formulæ proposed, but as the figures are so widely different it will be necessary to estimate the amount of iodine in iodide of starch prepared in different ways; I have not yet made any analyses of iodide of starch, but intend to do so if circumstances permit.

As the blue colour produced by the action of iodine on starch is of an interesting nature, I may mention as a sequel the few other cases in which a blue colour is produced by addition of iodine to organic substances.

1. A blue colour is produced when iodine is added to a solution of Iceland moss or Carragheen moss; this is due to the substance called lichenin, which is similar to starch in its composition and properties.

2. By the action of sulphuric acid on cellulose a body is produced which is blued by iodine.

3. In a paper by Frank E. Lott (*Journ. Soc. Chem. Ind.*, 495, 1887), in a description of Fritz's butyl bacillus, he says:—"The contents of the cells are partly coloured by iodine of a violet approaching black, either the whole contents or single isolated patches of it (two or three) or sometimes only one spot, I might add that the reaction with iodine does not take place at all stages of the growth of this organism. It depends, also, to a great extent, on the nourishing medium."

It is most probable that in the last two cases it was really starch that gave the blue colour.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 205).

Copper, Lead, Arsenic, and Antimony.

TEN grms. of the very finely-ground ore were treated with HCl, with the addition $KClO_3$, until only the siliceous residue remained unacted upon. It was then diluted, filtered, reduced with ammonic sulphite, all the excess of SO_2 was boiled off, and H_2S was passed through to saturation. The precipitate was allowed to settle in a warm place, and when the smell of H_2S had nearly passed off it was filtered on the pump, washed, and treated on the filter with KHS, to dissolve out the sulphides of arsenic and antimony. The filter containing the sulphides of copper and lead was dried and ignited in a porcelain crucible. The ignited sulphides were transferred to a small beaker and treated with HCl and HNO_3, excess of H_2SO_4 added, and the whole was evaporated down until SO_3 began to volatilise. Water was then added, and if any $PbSO_4$ separated out, an equal bulk of alcohol, and the whole was allowed to stand some hours, when the $PbSO_4$ was filtered off, dissolved in basic ammonic tartrate or acetate, and the PbS, precipitated by H_2S, was filtered, washed, and ignited. It was treated in the crucible (porcelain) with HNO_3 and H_2SO_4, and

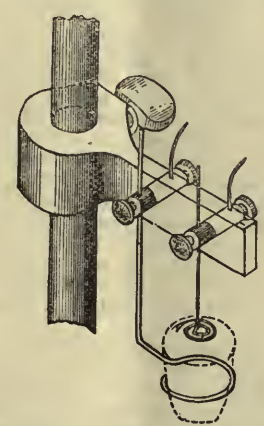

FIG. 9.—APPARATUS FOR COPPER DETERMINATION.

finally ignited and weighed as $PbSO_4$, which, multiplied by 0·6832, gave Pb. The solution containing the copper was evaporated down to drive off the alcohol, washed out into a platinum crucible, and the copper was precipitated on the crucible by the battery in the apparatus shown in Fig. 9, washed with water and alcohol, and weighed as Cu.

The KHS solution, containing the sulphides of arsenic and antimony, was acidulated with HCl and allowed to stand in a warm place until the sulphides and free sulphur had collected, and the solution smelled but faintly of H_2S. It was then filtered on the felt, and the precipitate, if it contained much free sulphur, was treated with carbon disulphide, transferred with the felt to a small beaker and treated with HCl and $KClO_3$, or aqua regia, which dissolved the arsenic and antimony very readily.

A little tartaric acid was added to keep the Sb in solution, the whole was diluted and filtered, excess of NH_4HO was added, and then magnesium mixture, and the arsenic precipitated as ammonic magnesic arsenate, with the same precautions that were used in the precipitation of P_2O_5. The precipitate was filtered on the felt, washed with dilute NH_4HO, dried at 100° C., and weighed as $Mg_2(NH_4)_2As_2O_8H_2O$.

It was then heated, very gradually at first, and finally to a full red, and weighed as $Mg_2As_2O_7$. The first weight obtained, multiplied by 0·3947, and the second by 0·4839, gave As. If the heat was applied carefully and slowly enough at first the latter result was most apt to be the correct one. The filtrate which contained the antimony was acidulated with HCl and the Sb was precipitated by H_2S with the usual precautions, filtered on a small disk of paper on the bottom of the perforated crucible, dried, and the precipitate and paper were treated in a porcelain crucible with fuming nitric acid, evaporated to dryness, ignited, and weighed as Sb_2O_4, which, multiplied by 0·7922, gave Sb.

Titanic Acid.

As titantic acid was found to interfere with the determination of phosphoric acid, so the latter was found in many cases to absolutely prevent the precipitation of the former. When the ore contained only a small amount of TiO_2, 5 grms. were treated with HCl, evaporated to dryness, re-dissolved in dilute HCl, filtered, the insoluble residue dried, ignited, and treated in the crucible with HFl and H_2SO_4. The solution in the crucible was evaporated down until all the HFl and H_2SO_4 were driven off, ignited, and the residue was fused with Na_2CO_3. The fused mass was treated with hot water, which dissolved the sodic phosphate, aluminate, and excess of sodic carbonate,* leaving insoluble the sodic titanate and any ferric oxide, calcic carbonate, baric carbonate, &c. The insoluble portion was filtered off, washed, dried, and put aside to be added to the TiO_2 in the soluble portion. The filtrate obtained after the first treatment of the ore with HCl, which contained the great mass of the iron, with the TiO_2, which, dissolved with it, was deoxidised by ammonic sulphite, the excess of SO_2 driven off, and the ferric phosphate, titanate, and small excess of ferric oxide were precipitated by ammonic acetate exactly as in the estimation of the P_2O_5. This precipitate was filtered off, washed, dried, and fused with Na_2CO_3, the fused mass was treated with water, filtered, and the insoluble portion, containing Fe_2O_3 and sodic titanate, was washed and dried. The two filters containing the sodic titanate were separated as carefully as possible from the adhering precipitates, ignited in a platinum crucible, the precipitates were added, and the whole was fused at a low heat with 15—20 times the weight of acid potassic sulphate. The heat was gradually increased to a dull red and kept at this point until the fusion was perfectly clear and of a reddish brown colour. It was then cooled and treated with a large excess of cold water containing a few drops of H_2SO_4, with constant stirring until nothing remained undissolved except, perhaps, a little SiO_2. It was then filtered, washed with cold water, the filtrate was diluted to about 500 c.c., and boiled in a large platinum dish or beaker, with the constant addition of strong aqueous solution of sulphurous acid until all the TiO_2 was precipitated. The precipitate was allowed to settle, the clear solution was decanted through a filter, the precipitate was boiled up with water, thrown on the filter, and washed with boiling water, dried, ignited cautiously, and weighed as TiO_2. The filtrate was boiled again with the addition of sulphurous acid, and any further precipitate filtered off and added to the first. It was found that when the solution was kept at the boiling point during the filtration, and the precipitate washed with boiling water, there was no tendency to pass the filter; whereas if the solution was allowed to get cold, the filtrate was nearly always cloudy. To prevent the precipitation of ferric oxide with the TiO_2, it was necessary to keep an excess of SO_2 in the

* From "Mining Industries of the United States."

* Any tungsten in the ore would be in this solution as sodic tungstate.

solution; but if, in spite of this precaution, the ignited TiO_2 was coloured with Fe_2O_3, it was fused again with $KHSO_4$ and re-precipitated. In the analysis of ores containing much TiO_2 it was preferable to fuse the ore at once with Na_2CO_3, treat with water, filter, wash and dry the residue, separate and burn the filter, fuse the residue and filter-ash with $KHSO_4$, and determined the TiO_2 as before.

Determination of Specific Gravity.

A great many experiments were made both on lumps and on powdered ore, and it was decided that in commercial samples good results could be obtained only by using the powdered material. The work was done, and the flask herein described was made by Mr. James Hogarth. About 20 grms. of the powdered sample were weighed out and transferred to the specific gravity flask, the construction of which is shown in Fig. 10. This flask was made with the view of overcoming two difficulties which occur in using the common flask, viz., the expansion and

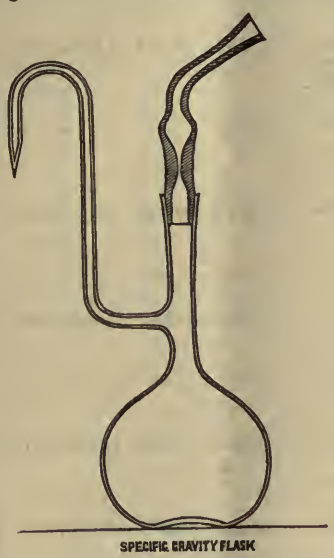

Fig. 10.

overflow consequent on transferring the flask at 60° F. to the higher temperature of the balance-case, and the necessity for waiting until the finely divided mineral had settled before the stopper could be inserted without loss of material. These ends were successfully met by melting on a capillary tubulus to the lower part of the neck and grinding in a stopper having a small bulb above the capillary, to allow for expansion.

Having transferred the weighed quantity of ore to the flask enough water was added to cover it, and the temperature was raised almost to the boiling point by placing the flask in a water-bath. To insure complete expulsion of air the flask was now placed under a bell-jar connected with the aspirator and allowed to boil for a few moments at the reduced pressure. It was then filled up with water almost to the tubulus, cooled, the stopper was inserted, and by suction it was filled up slightly above the mark on the capillary part of the stopper. When the thermometer was stationary at 60° F. the volume was adjusted by touching the capillary end of the tubulus with blotting-paper, or by bringing a drop of water to it, as the case might require. The flask was then dried, transferred to the balance-case, and, after a sufficient time had elapsed to allow it to take the temperature of the room, weighed.

If W be the weight of ore taken, W′ the weight of ore + water at 60°, and K the weight of the flask + water at 60°, then

$$\text{Sp. gr.} = \frac{W}{W+K-W'}.$$

To obtain K the flask was nearly filled with boiled water and treated exactly as described above.

(To be continued).

REPORT OF THE COMMITTEE OF THE BRITISH ASSOCIATION*

APPOINTED FOR THE PURPOSE OF INVESTIGATING THE

INFLUENCE OF SILICON ON THE PROPERTIES OF STEEL.

When the above Committee were appointed at the last meeting of the Association, a series of experiments had already been commenced, and a preliminary notice of these appeared in the Report for last year. This series of experiments has been completed, and full details have been published (*Jour. Chem. Soc.*, 1887, p. 129). A second set of observations in continuation of the work has also been commenced, and the results are so far advanced that it is hoped to publish details in a few months.

In the paper in the *Journal of the Chemical Society* a short account is given of the results hitherto obtained by other observers, and it is believed that the present state of our knowledge may be summarised as follows:—

1. Ingot iron. Silicon promotes soundness; it resembles carbon in increasing the tenacity and hardness; it should not exceed 0·15 per cent if the metal has to be rolled; and in some cases it produces brittleness when cold.

2. In steel castings. Silicon promotes soundness; it is, however, regarded as a necessary evil, and excess should be avoided, as tending to brittleness and low extension: about 0·3 per cent is generally recommended.

3. In crucible steel. A few hundredths per cent is necessary to produce soundness; it is generally agreed that considerable quantities of silicon may be present without injury to the material.

4. Manganese appears to be capable of neutralising the ill effect due to silicon.

The first series of experiments was undertaken to determine the effect of silicon on the properties of specially pure iron. For this purpose molten iron was taken from the Bessemer converter at the end of the "blow" and before any addition of ferro manganese had been made. This was mixed in a crucible with various proportions of melted cast-iron containing about 10 per cent of silicon, and the product was afterwards examined. The composition of these materials was as follows:—

	C.	Si.	S.	Mn.	P.
Bessemer Iron	0·02	0·0098	0·039	0·06	0·04
Silicon Pig	1·96	10·30	0·02	1·90	0·17

In Table A is given a general summary of the results obtained. The mechanical tests were conducted by Professor A. B. W. Kennedy, and duplicate experiments gave concordant results. The mean values deduced from these experiments are given in Table B. The letter D is used to indicate that in these cases it is doubtful if thorough mixture was obtained. Other ingots were prepared containing more silicon, but as these could not be rolled no mechanical tests were performed.

The relative hardness was determined, as in my experiments on cast-iron, by means of the weight in grms. necessary to produce a scratch with a diamond on drawing its point over the smooth surface of the metal. The following list will illustrate the values obtained on applying such a method of examination to various substances. On comparing the values given in Table B it will be seen that the relative hardness was not very greatly influenced by the proportion of silicon added.

* Consisting of Profs. Tilden and W. Chandler Roberts-Austen and Mr. T. Turner (Secretary). Drawn up by Mr. T. Turner.

TABLE A.—*General Summary of Results.*

No.	Chemical analysis. (By Mr. J. P. Walton). C.	Si.	S.	Mn.	P.	Hot tests.	Cold tests.	Welding tests.	Specific extension. e_t	e_c	Modulus of elasticity. E	E_c
1.	0·02	0·0098	0·039	0·06	0·04	Worked well at welding heat; red short at dull red heat.	Good.	Perfect weld.	0·317	0·314	31,590,000	31,870,000
	—	—	—	—	—	—	—	—	—	—	—	—
2.	0·029	0·02	0·03	0·10	0·03	Do.	Do.	Broke owing to red shortness.	0·326	0·329	30,640,000	30,420,000
	—	—	—	—	—	—	—	—	—	—	—	—
3.	0·02	0·027	0·028	0·07	0·042	Do.	Do.	Very good weld.	0·321	0·321	31,120,000	31,120,000
	—	—	—	—	—	—	—	—	—	—	—	—
4.	0·076	0·035	0·03	0·10	0·06	Do.	Do.	Do.	0·328	0·320	30,530,000	31,250,000
	—	—	—	—	—	—	—	—	—	—	—	—
5.	0·057	0·039	0·03	0·09	0·05	Do.	Do.	Do.	0·330	0·321	30,300,000	31,120,000
	—	—	—	—	—	—	—	—	—	—	—	—
6.	0·052	0·08	0·036	0·09	0·06	Do.	Do.	Do.	0·311	0·323	32,130,000	31,000,000
	—	—	—	—	—	—	—	—	—	—	—	—
7.	0·113	0·117	0·015	0·08	0·045	Do.	Do.	Do.	0·333	0·326	30,070,000	30,640,000
	—	—	—	—	—	—	—	—	—	—	—	—
8.	0·034	0·113	0·033	0·09	0·08	Do.	Do.	Not so good.	0·312	0·313	32,100,000	32,000,000
	—	—	—	—	—	—	—	—	—	—	—	—

Substances.	Relative hardness.
Steatite	1
Lead (commercial)	1
Tin	2·5
Rock salt	4
Zinc (pure annealed)	6
Copper (pure annealed)	8
Calcite	12
Softest iron	15
Fluor-spar	19
Mild steel	21
Tyre steel	20—24
Good cast-iron	21—24
Bar-iron	24
Apatite	34
Hard cast-iron scrap	36
Window-glass	60
Good razor steel	60
Very hard white iron	72

The following are the general conclusions arrived at from this series of experiments. On adding silicon, in the form of silicon pig, to the purest Bessemer iron, the following results are obtained :—

The metal is quiet in the mould when even a few hundredths per cent of silicon is added. The metal is originally red-short, especially at a dull red heat, though it works well at a welding temperature; the red-shortness is increased by silicon. In all cases examined, the metal was tough cold, and welded well, silicon having little or no influence. Silicon increases the elastic limit and tensile strength, but diminishes the elongation and the contraction of area, a few hundredths per cent having a remarkable influence in this respect. The appearance on fracture by tensile force is changed from finely silky to crystalline, while the fracture produced by a blow gradually becomes more like that of tool steel as silicon increases. The hardness increases with the increase of silicon, but appears to be closely connected with the tenacity. With 0·4 per cent of silicon and 0·2 per cent of carbon, a steel

General Summary of Results (continued).

Limit of elasticity per sq. in.		Breaking load per sq. in.		Ratio of limit to break.	Extension p.c. on 10 in.	Reduction of area per cent.	Relative hardness.	Remarks.
Pounds.	Tons.	Pounds.	Tons.					
28,600	12·77	48,850	21·80	0·586	24·7	76·3	18	Silky.
29,680	13·25	48,810	21·79	0·608	30·7	77·8	—	Very finely silky.
30,000	13·39	46,410	20·72	0·646	19·5	43·4	16	Fracture irregular; about 60 per cent silky; the remainder in patches and pipes of crystal.
28,610	12·77	42,940	19·17	0·666	15·7	37·3	—	Very unsound and faulty; irregular crystalline spots; surface extremely distressed all over.
36,530	16·30	49,040	21·89	0·744	24·2	63·7	15	Fracture silky, but full of pipes and reedy holes in part filled with crystalline siliceous matter; some small specks of crystal.
42,980	19·19	48,410	21·61	0·888	27·8	71·1	—	Very finely silky, but with three large and about 20 small round pipes, filled with siliceous matter, which flew out in a cloud of dust on fracture; surface reedy.
33,860	15·11	51,920	23·18	0·652	15·6	30·0	17	Fracture irregular, with unsound pipes or fissures; mostly crystalline granular; edges silky.
36,470	16·28	51,430	22·96	0·709	17·1	33·7	—	Like No. 6, but more irregular, and surface a good deal distressed.
34,090	15·22	50·640	22·60	0·673	15·4	36·3	17	Fracture irregular and not entirely sound; about 30 per cent finely crystalline, rest silky.
39,490	17·63	53·670	23·97	0·735	21·1	39·1	—	Irregular; mostly silky, but with crystalline spots, in places unsound and reedy; surface reedy.
40,160	17·92	54,280	24·23	0 739	24·0	46·0	20	Silky, but with irregular crystalline specks and pipes.
34,780	15·53	52,050	23·24	0·668	24·5	43·8	—	Silky but irregular, with crystalline spots and pipes; surface a little distressed.
39,730	17·73	61,490	27·45	0·646	12·8	19·7	21	Fracture 65 per cent finely crystalline, the rest half finely granular; half silky; surface very much distressed on one side.
40,920	18·27	64,180	28·65	0·638	18·4	33·9	—	Fracture about 65 per cent finely crystalline, the rest irregular, for the most part silky; surface a good deal distressed.
41,620	18·58	57,720	25·77	0·721	22.0	47·7	20	Silky; specked with crystals and silica (yellowish crystalline material), a little reedy on surface.
40,710	18·17	57,330	25·59	0·710	17·7	36·2	—	Somewhat irregular, silky—with flattened pipes containing crystalline siliceous matter; surface a little distressed.

TABLE B.—*Mean Results of Tensile Tests.* Professor KENNEDY.

No.	Si p.c. found.	Limit of elasticity. Tons per sq. in.	Breaking load. Tons per sq. in.	Ratio limit to break.	Extension per cent on 10 inches.	Reduction of area per cent.	Relative hardness.
1	0·0098	13·01	21·80	0·597	27·7	77·0	18
2	0·02	13·08	19·95	0·656	17·6	40·3	16
D 3	0·027	17·75	21·75	0·861	26·0	67·4	15
4	0·035	15·69	23·07	0 680	16·3	31·8	17
5	0·039	16·42	23·28	0·704	18·2	37·7	17
6	0·08	16·72	23·77	0·704	24·2	44·9	20
7	0·117	18·00	28·05	0·642	15·6	26·8	21
D 8	0·13	18·37	25·68	0·715	18·8	41·9	20

was obtained difficult to work at high temperatures, but tough when cold, capable of being hardened in water, and giving a cutting edge which succesfully resisted considerable hard usage. In some cases silicon was present in the oxidised condition; the effect is then very different, and the mechanical properties of the metal more nearly resemble those of the original Bessemer iron.

In the second series of experiments various proportions of silicon have been added to ingot metal, containing manganese and carbon, as ordinarily met with in commerce.

The results are not yet quite ready for publication, but they show that manganese greatly modifies the effect of silicon in producing red-shortness, and hence enables the metal to be readily rolled and otherwise worked, even in presence of several tenths per cent of silicon. The low extension, however, though not nearly so marked as before, is still observed, despite the presence of manganese; and hence, for the majority of the applications of mild steel, silicon does not appear to be advantageous.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

November 12th, 1887.

Prof. W. E. Ayrton, F.R.S., Vice-President, in the Chair.

Lieut. Bacon, R.N., was elected a member of the Society.

Owing to the illness of Dr. Shettle the paper announced to be read by him was postponed.

The following communication was read:—

"*On a Geometrical Method of Determining the Conditions of Maximum Efficiency in the Transmission of Power by Alternating Currents.* By T. H. Blakesley, M.A.

In this paper the author confines himself to the consideration of a simple circuit containing generating, conveying, and recipient parts, in which the E.M.F. follows the law of sines.

The maximum E.M.F. of both machines are supposed known, together with the resistance and coefficient of self-induction of the complete circuit.

The variable on which the efficiency of transmission depends is the difference of phase of generator and receiver. A geometrical construction is given by which the phase which gives maximum efficiency can be determined.

Mr. Kapp thought the construction would not apply apply where the receiver does mechanical work, owing to the E.M.F. not being a true sine function of the time. He also mentioned an experiment performed on a motor driven successively by alternating and direct currents, in which the *apparent* power—

$$\left(\sqrt{\varepsilon^2}\ \sqrt{c^2}\right)$$

supplied by alternating currents was about five times that required when direct currents were used, the motor giving out the same power in the two cases. From this he inferred that the ratio of power to weight is much greater for a direct than for an alternating current motor. This he considered a serious drawback to the use of alternate currents for transmitting power.

After some remarks by Prof Ayrton and Prof. S. P. Thompson, Mr. Blakesley said that by placing a condenser between the terminals of the recipient machine a greater current could be passed through the receiver than that in the generator and line.

Prof. A. W. Rücker exhibited and described a Lecture experiment for determining the velocity of sound.

The principle of the arragement is that used by Fizeau in determining the velocity of light. A vibrating reed is used as the source of sound and a sensitive flame as receiver.

A long U-shaped tube has its two ends placed near and parallel to the plane of a perforated disc, which is capable of rotating about an axis perpendicular to its own plane. The reed and sensitive flame occupy similar positions on the opposite side of the disc.

On rotating the disc the sensitive flame flares or is quiescent, according as the time taken to travel the length of the tube is an even or an odd multiple of $\frac{T}{2n}$, where T is the time of one revolution and n the number of holes in the disc.

Mr. Bosanquet exhibited a form of polariscope he had made some time ago for researches on the polarisation of the sky.

Its chief feature is a compound prism of right- and left-handed quartz, which shows coloured bands with polarised light whatever be the direction of the plane of polarisation. It also forms a very sensitive object for polarimeters.

NOTICES OF BOOKS.

*Milk: Chemical and Micro-biological Studies.** By E. Duclaux. Paris: J. B. Baillière et Fils.

This work is something more than a mere guide to the analysis of milk, its components, and its products. The author studies the constitution of this important secretion, and the changes which it as well as butter and cheese undergo, especially from the action of ferments. To all who wish to undertake its examination he recommends certain precautions not generally taken. The milk may be introduced at once into tubes, which are then sealed and heated to 115°. Or test-tubes are fitted with a plug of cotton-wool, moderately compact. These tubes are then sterilised by heating to 120° to 130°. The teat of the cow is carefully washed, and, after a little milk has been drawn to clear the dust, a sufficient quantity is drawn into the tube, which is held quite close to the teat, but not touching, the plug of cotton having been first removed with forceps. As soon as the tube is full the plug is returned to its place. On prolonged standing the milk separates into a number of strata, the fatty matter floating uppermost.

The first part of the book is occupied with the examination of butters. A general method is laid down for their analysis, the matters to be determined being water, fatty matter, common salt, volatile fatty acids (free and combined), milk-sugar, and fatty acids in the state of glycerides. In this last determination the author saponifies with potassa, but he disapproves of the simultaneous use of alcohol, as recommended by Hehner and Angell.

He then compares recent butters of known gravity with the more or less rancified butters of commerce. To understand the changes which the latter have undergone he studies the influence of three factors—oxygen, light, and microbia. As regards the latter, their effects upon the fatty matter of butter are blended with those sustained by the caseine present.

In the second part M. Duclaux takes up the study of caseine,—a very complicated question. He rejects the views of Danilewski and Radenhausen, who regard caseine as a complex of eight bodies; and he contends that even the albumen of milk, its caseine, and its lacto-proteine (albumen) are one and the same substance in different conditions of solution. An elaborate study of rennet is next to be found.

The various methods for the analysis of milk are considered at some length. The author sets aside as inexact the procedures of Hoppe-Seyler, of Millon, and Commaille. He notices also, briefly, the methods of Payen, Storch, and Ritthausen; but that of Mr. Wanklyn is entirely ignored.

Quevenne's lacto-densimeter, or as it is called in this country, lacto-meter, is fairly judged,—that is, condemned, M. Duclaux points out that the surface-tension of milk is different from that of a saline solution, and hence an instrument graduated according to the latter will give false results with milk. But he overlooks the fact that

* "Le Lait: Etudes Chimiques et Micro-biologiques."

all methods of judging the quality of milk by its specific gravity, however obtained, are deceptive. We have heard of samples of milk being condemned because they contained an unusual proportion of cream, and were consequently lighter than the normal standard. We thought that all chemists who undertake the analysis of articles of food must be aware that a dealer can lower the specific gravity of a sample of milk by skimming, and can then raise it to its original point by the judicious addition of wator. The creamometer and the lactoscope are likewise pronounced untrustworthy, but the lacto-butyrometer of Marchand is considered suitable for rough-and-ready testing.

The author's own method for the analysis of milk forms the subject of a special chapter. He determines the specific gravity and the ash, the milk-sugar, the dry residue (total solids), and the fatty matter, and the caseine (suspended and dissolved). He does not notice the method for the determination of fatty matter proposed by Mr. Adams, of Maidstone, which, we learn, is gaining favour in Germany. In determining the dry residue he condemns the addition of sand or other pulverulent matter, which he finds retards perfect desiccation, or even renders it impossible. He uses, instead, pieces of sponge about the size of a nut, which are first very carefully washed, then dried, and preserved in ether until wanted. He considers that these sponges, when saturated with the milk and dried, present the fatty matter in a very suitable state for extraction in ether.

Judging from his analysis asses' milk is ten times dearer than cows' milk, and is worth three times less. The question, however, remains whether it does not present nutritive matter in a state better suited for assimilation by the human digestive organs than is the milk of the cow. Its proportion of milk-sugar is much higher than in that of the cow or the goat, and approaches that of woman.

The remaining portion of the work discusses the manufacture of cheese, the process of ripening, the general method for the analysis of cheese, and the characteristics of some of the most esteemed kinds,—such as those of Cantal, Brie, Gruyère, and the Parmesan, those of Gorgonzola and Roquefort. Of foreign cheeses the author mentions those only of Parma and of Holland.

This book is well worth the attention of public analysts, agricultural chemists, and of intelligent manufacturers of cheeses.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 12, June 26, 1887.

Action of Selenious Acid upon Manganese Dioxide.—P. Laugier.—Selenious acid in solution attacks natural manganese dioxide very slightly, even after prolonged boiling. There is found a crystalline orange substance mixed with a large excess of undecomposed peroxide. Small quantities of manganous seleniate are found in solution. In sealed tubes at 140° the results are similar. Hydrated manganese dioxide is readily attacked, yielding a brown solution which decomposes almost spontaneously into an orange-yellow matter, and a manganous seleniate which remains in solution. It is a basic sesqui-manganese selenite.

Action of Acetylene upon Benzene in presence of Aluminium Chloride.—M. Raoul Varet and G. Vienne.—The principal products of the reaction are cinnamene, diphenyl-ethane, and dibenzyl.

On Two Isomeric Mono-nitro-Camphors, derived from Ordinary Camphor.—P. Cazeneuve.—Already noticed.

Supplementary Note on Chloro-nitro-Camphor β.—P. Cazeneuve.—Already noticed.

Influence of Temperature on the Speed of the Reaction of Marble with certain Mineral Acids.—W. Spring.—The speed of the reaction is approximately doubled on an increase of 20° of temperature.

Justig Liebig's Annalen der Chemie.
Vol. ccxxxix., Part 2.

Communications from the Chemical Institute of the University of Bonn.—These consist of papers on the anilides of fumaric and maleic acids, and on phenyl-asparagic acid, by R. Anschütz and Q. Wirtz, and on the isomerism of fumaric and maleic acids, by R. Anschütz.

Communications from the Chemical Laboratory of the University of Würzburg.—These communications comprise papers by Emil Fischer on the urea-derivatives of dibrom-pyruvic acid; by E. Fischer and O. Knœvenagel on the compounds of phenyl-hydrazine with acroleine, mesityl oxide, and allyl bromide; by Rich. Arheidt on diphenyl-dihydrazine; by A. Piülf on hydrazine benzol-sulpho-acids; by the same author on certain indoles; by Jul. Raschen on indoles from the tolyl-hydrazines; by A. Schlieper on indoles from α-naphthyl-hydrazine; by Max. Wenzing on derivatives of the three methyl-indoles; and by E. Fischer on the hydrazines.

Notices on Zirconium.—O. Hinsberg.—The author has attempted to form zirconium ethyl, but finds that it is not capable of existing under the conditions of his experiments. He has obtained a zirconium hydrox-iodide $ZrI(OH)_3$. It is an amorphous colourless powder, which, on exposure to the air, turns brown and loses iodine. It is readily soluble in water. The author did not succeed in obtaining an iodide, ZrI_4.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., August, 1887.

Examination of the Leaves of Gymnema silvestre.—David Hooper.—This paper, evidently of English origin, is said to be taken from "*Journal Nature*."

Action of Hydrofluoric Acid upon Silica and the Silicates.—J. B. Mackintosh.—From the *School of Mines Quarterly*.

Transparence of Cast-Iron.—W. Ramsay.—From the Chemical News.

Manufacture of Vinegar.—This memoir, taken from the *Journal Vinicole*, contains instructions for the conversion of alcohol into vinegar.

Detection of Fusel Oils.—The *Brennerei Zeitung* maintains that the evil flavour of potato-spirit depends less on the quantity of fusel oil present than on its quality. Grain spirit improves with age, which is not the case with potato-spirit.

Freezing-Mixtures.—F. Fol (from the *Chemiker Zeitung*).—The author has experimented on the reduction of temperature caused by mixtures of ethylic and methylic alcohol, and ether with snow. He finds that 100 parts of glycerin mixed with 300 parts of snow give a mixture at 20° (probably − 20). These experiments suggest a possible method for detecting the adulteration of extracts of dye-woods with syrup. The author finds that pure extract of chestnut (sp. gr. 1·210), mixed with an equal weight of snow, gave a temperature of 2°, whilst under the same circumstances an extract of chestnut of the same specific gravity, but adulterated with a solution of sugar, stood at 3·5°.

Hydrogen Peroxide in Brewing.—G. Reisenbichler.—Hydrogen peroxide serves in the first place to free the

water from living organisms. It also destroys in the wort the acid and mould ferments. In stronger doses it destroys the alcoholic ferment and stops fermentation.

NOTES AND QUERIES.

*** Our Notes and Queries column waa opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Asphaltum.—Could you kindly inform me through your correspondence column of any work which contains the chemical composition of raw asphaltum?—E. Price.

Destroying Fish.—Explosives, such as dynamite or gunpowder, are very effective by the shock. If preferred, bread soaked in a strong decoction of bruised *Cocculus indicus* (strained), may be strewn upon the water. Fish, on eating this, become stupefied, and are easily caught. Why not drag the lake?—G. A. Keyworth.

Manufacture of Oxygen.—Under "Notes and Queries" of your issue of the 11th inst. I notice an enquiry as to who are the manufacturers of oxygen under the Brin process. You are perhaps aware that this Company is the proprietor of the Brin processes.—T. N. Hester, Secretary, Brin's Oxygen Company, Limited, Connaught Mansions, Victoria Street, Westminster, S.W., Nov. 15, 1887.

MEETINGS FOR THE WEEK.

Monday, 21st.—Medical, 8.30.
Tuesday, 22nd.—Royal Medical and Chirurgical, 8.30.
—— Institution of Civil Engineers, 8.
Wednesday, 23rd.—Society of Arts, 8. "The Mercurial Air-pump," by Prof. Silvanus P. Thompson, D.Sc.
—— Geological, 8.
Thursday, 24th.—Royal, 4.30.
—— Telegraphic Engineers, 8.
Friday, 25th.—Quekett Club, 8.
Saturday, 26th.—Physical, 3. "On the Analogies of Influence Machines and Dynamos," by Prof. S. Thompson, D.Sc. "Effect produced on the Thermo-electrical Properties of Iron when under Stress or Strain by raising the Temperature to a Bright Red," by H. Tomlinson. "Optical properties of Phenyl-thiocarbimide," by H. G. Madan.

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BADISCHE ANILIN AND SODA FABRIC.

PATENTS FOR DYES AND COLOURING MATTERS.

NOTICE IS HEREBY GIVEN that on the 26th day of July, 1887, the Judgment of Mr. Justice Pearson in the Action of The Badische Anilin and Soda Fabrik v. Levinstein (High Court of Justice, Chancery Division, 1881 B., No. 5077), whereby the validity of the Letters Patent of 25th February, 1878, No. 786 (Red and Brown Dyes), was established, and an Injunction restraining the Defendants from infringing the said Letters Patent waa granted to the Plaintiffs with the usual account of profits and other relief, was affirmed by the House of Lords, and the Defendants were ordered to pay to the Plaintiffs the costs incurred by them in the Courts below and also the costs incurred by them in respect to the Appeals to the House of Lords. All persons (not being Licensees of the Badische Anilin and Soda Fabrik) are hereby cautioned not to make, sell, or use, or import into the United Kingdom any Red or Brown Dyes or colouring-matters made according to the Invention comprised in the above-mentioned Lettera Patent.

Dated this 11th day of November, 1887.

J. H. and J. Y. JOHNSON,
47, Lincoln's Inn Fields, London, W.C.,
Solicitors to the Badische Anilin and Soda Fabrik.

MR. J. S. MERRY,
ASSAYER AND ANALYTICAL CHEMIST
SWANSEA.

WILLIAM FOX, Analytical Chemist.
LABORATORY:
40, GREAT TOWER STREET, LONDON. E.C.
Analyses of Oils, Pigments, Varnishes, &c.

American Exhibition closed October 31st,

But, owing to the large number of orders now in, orders will be received and filled there till November 23rd.
(On account of the Holiday and unlimited work in Philadelphia this is the latest day orders can be filled).

PROF. A. E. FOOTE, of Philadelphia, would call attention to the short time remaining in which choice American Minerals can be had at low prices.

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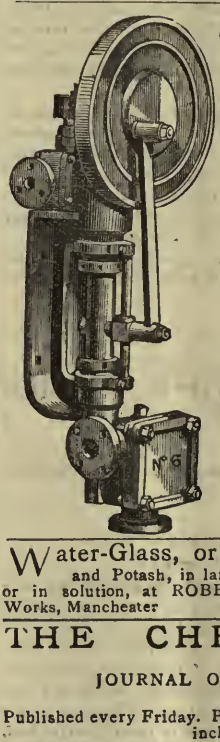

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THE CHEMICAL NEWS.

Vol. LVI. No. 1461.

SENSITIVENESS OF TASTE.

By F. P. VENABLES, Ph.D., F.C.S.

The recent experiments of Fischer and Penzoldt ("Ueber die Empfindlichkeit des Geruchsinnes," *Liebig's Annalen der Chemie*, ccxxxix., p. 131) have led me to search for some record of similar experiments determining the limits of the sense of taste. Finding none, an investigation was undertaken in which the following experiments were made.

The substances examined were weighed and then dissolved in known volumes of the appropriate solvent. This solvent was generally water, and water was always used in dilution, so that the taste was not interfered with by the solvent. To eliminate personal error two persons acted as tasters. In each case one cubic centimetre of the solution was tasted. The solutions were diluted to a point at which the taste was barely perceptible (in some cases perceptible to only one of the experimenters), and that was taken as the limit.

The results were as follows :—

Sugar.—3-1000ths of a grm. barely tasted.
Salt (NaCl).—1-1000th of a grm. barely tasted.
Tannin.—2-10,000ths tasted; 1-10,000 failed to taste.
Hydrochloric acid.—1-10,000th of a grm. barely tasted.
Saccharin.—5-1,000,000ths of a grm. barely tasted.
Strychnin.—5-10,000,000ths of a grm. barely tasted.

University of North Carolina, U.S.A.

THE ESTIMATION OF SILICON IN IRON AND STEEL.

By J. JAS. MORGAN.

Mr. Turner, in an article in the Chemical News, vol. lvi., p. 49, on "The Estimation of Silicon in Iron and Steel," states that it is extremely difficult to thoroughly remove the last trace of iron from the residue after evaporation of phosphoric irons with aqua regia, and gives results of some experiments which he has made to prove his statement.

This difficulty of obtaining a silica perfectly free from iron by the aqua regia method has been long known to metallurgical chemists, and was drawn attention to some ten or twelve years ago, in an article, either in the Chemical News, or the *Journal of the Chemical Society*, by Mr. Riley, who attributed it to an insoluble phosphide of iron.

Mr. Turner also states that "with phosphoric irons containing titanium, the silica is contaminated with titanium."

From this it is evident that Mr. Turner is ignorant of the fact, viz., that part of the titanium remains behind in combination with the silica, obtained by treating the iron with aqua regia, whatever the amount of phosphorus present, be it large or small.

It is found that if the evaporation of the solution, obtained by treating four grms. of the iron with aqua regia, be arrested upon its attaining a thick syrupy condition, so that it is with difficulty poured round the sides and bottom of the dish when given a circular movement, the silica obtained upon subsequent treatment with hydrochloric acid, washing three or four times with dilute hydrochloric acid, and twelve times with hot water, is white and free from phosphorus and iron, as was proved by fusion with acid potassium sulphate, when the percentage of silicon found agreed, within experimental error, with that originally obtained, and also by the filtrate being free from phosphorus and iron.

The author has made a large number of experiments with this modified process, and obtained results agreeing with the percentages of silicon calculated from the silica obtained by the usual method after fusion with acid potassium sulphate to purify.

The following are a few results.

	Methods.			
Exp.	Evap. to complete dryness, with subsequent fusion with pot. sulph. Silicon, p.c.	Mod. process. Silicon p.c.	Mod. process with subsequent fusion with pot. sulph. Silicon p.c.	Phos. p.c.
I.	0·932	0·932	0·932	0·860
II.	1·780	1·773	1·779	0·860
III.	0·587	0·563	0·560	0·936
IV.	0·705	0·700	0·701	0·854

THE INTERACTION OF ZINC AND SULPHURIC ACID.

By V. H. VELEY, M.A.

As unfortunately I was unable to be present at the meeting of the Chemical Society at which Messrs. Pattison Muir and Adie's paper was read and discussed, and as others, notably Mr. Spring, besides myself are engaged on parallel lines of research, I would venture to offer here a few remarks on the subject. It appears that Mr. Spring's results (*Ann. Chim. Phys.*, August, 1887), obtained by a measurement of the rate of evolution of hydrogen, do not adequately represent the rate of chemical change as comparable, for example, with the rate of evolution of gas from a homogeneous liquid; for it is to be noticed that, when a regular surface of metallic zinc is placed in sulphuric acid, the bubbles of hydrogen at first cling to the surface and gradually increase in size until they assume such dimensions that they overcome their cohesion with the surface. This may to some account form the phenomenon of initial retardation observed by Spring. Secondly, though the evolved bubbles of gas may to some extent remove the solution of zinc salt from the vicinity of the dissolving metal, yet if the liquid is carefully poured off it will readily be observed that that portion which has been immediately in contact with the metal is of a different specific gravity from the rest, is in fact a concentrated solution of the metallic salt. The hydrogen evolved is a resultant of a series of changes, each one of which is variable at any moment, such as the rate of diffusion of the salt of the metal in the acid liquid, the amount of surface exposed, which Spring kept approximately constant, and the local rise of temperature caused by the heat evolved. The amount of gases other than hydrogen, such as sulphurous oxide and hydrogen sulphide, are, doubtless, dependent upon the more or less perfect removal of the product of the change from the sphere of the dissolving metal as well as upon the concentration of the acid solution. On the other hand, it does not appear that variations in the relative masses of zinc would make any difference either in the rate of solution or in the products of the change were the surfaces exposed in all cases equal. The dissolution of a solid in a liquid cannot but be regarded as a superficial action only. For the present I would merely wish to mention that I am engaged in a research in which the rate of dissolution of metals in acids is being investigated under such conditions that not only fresh surfaces of a regular geometrical figure of metal are continuously being exposed, but also the products of the change, whether gas or metallic salt, are at once and continuously removed from the vicinity of dis-

solving metal; thus, the effect of local rise of temperature would also be reduced to a minimum.

University College, Oxford,
Nov. 14, 1887.

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

I INTENTIONALLY omit many preliminary points in connection with butter examination, although I do not ignore their value.

Ten grms. of the butter is carefully weighed and transferred to a tared filter-tube, plugged with asbestos, which has previously been well washed with carbon disulphide to remove any loose fragments of asbestos; the plugged tube is then carefully dried and weighed. About 100 c.c. of pure carbon disulphide, or more if required, are poured over the butter gradually and allowed to filter through, more disulphide is added, so as to remove every trace of fatty matter.

The filtrate is received in a tared porcelain basin, which is carefully evaporated over hot water; when every trace of solvent has been removed it is cooled and again weighed. The difference between this and the original weight is due to salt, caseine, water, extractive colouring-matter, which has been added, &c., insoluble in disulphide carbon.

The fatty matter is again dissolved in about its own volume of disulphide carbon, and the same volume of yellow chloride sulphur, diluted with an equal measure of disulphide carbon added with constant stirring. The disulphide is completely evaporated over hot water. This part of the process ensures the reaction of the chloride sulphur.

The resulting thickened mass should yield a perfectly clear solution with disulphide carbon. An insoluble residue will indicate the presence of any vegetable oil, notably those which are used in the manufacture of oleomargarine or butterine. In fact, it is absolutely impossible to add to or to substitute for butter any vegetable oil product with which I am at present acquainted.

The filter tube is carefully dried and then weighed; to the weight of the residuum in the tube is added the weight of the fat extracted; the loss from the original weight is that of the water. It is next treated with warm distilled water, which will dissolve out the salt and colouring-matter. According to the colour of the fat itself and quantity of colouring-matter, an insight may be gained as to what the original butter was when it left the churn, at least before being churned with "the chemicals." It does not, of necessity, point to adulteration, as colouring-matter is frequently added to improve the appearance of the real dairy product. The filter tube is finally washed out with dilute liq. ammonia, until every trace of caseine has been removed, which may be re-precipitated with hydrochloric acid, collected on a tared filter, dried, and weighed. Water is passed through the tube, which is then dried and weighed. Starch or any other foreign matter not previously removed can easily be detected.

In examining good samples of country butter in this way I have been struck with the large amounts of caseine present, in one sample obtained from a respectable family grocer, and for which 20d. per lb. was paid: I found 15 per cent caseine and about 85 per cent soluble fats, with traces of water, salt, and a yellowish colouring-matter.

I am not aware that caseine has been referred to by English chemists as an important adulterant of butter, but Chateau speaks of "lait durci au feu" as a source of fraud. I propose, on a future occasion, to examine this portion of the subject more minutely.

It seems to me that Chambers of Agriculture may well take this matter up, for if the mischief is produced by the real dairy farmer the sooner it is stopped the better. I am, however, inclined to think that we must look to another quarter for this fraud.

Many dairy farmers do not work up their own milk, but sell the same to some manufacturing firm, who manipulate the milk for the recovery of curd, &c. This is a fraud which does a great injustice to the dairy farmer and to the agricultural interest in particular, to say nothing of the consumer.

If we are to contend with the fraudulent sale of oleomargarine as butter, we must impress on those whose interest it concerns that there must be no tampering with the product yielded by good wholesome milk.

The *permissive character* of legislation on such subjects connected with adulterations has done more towards the depravity of our national candour than one cares to think about too much.

Animal fats, such as lard, lard oil, &c., behave very much like butter, and are so far capable of being blended with it, but the tests already in use amply provide against this source of fraud.

I may just say that the fearful frauds now practised with lard oil, and the addition of rosin or rosin oil in any form, and also petroleum, to any vegetable oil, are instantly detected by this method of testing.

Are our oil experts aware of the incentive to dishonesty which they hold out to an unscrupulous vendor. Chloride of sulphur has been recently condemned for this purpose of testing oils; I suppose it clashes too severely with the interest of the oil trade. I simply protest against any chemist using his position as an ægis for the questionable practice of others.

I am indebted to Mr. Edwin Bruce Warren for the experimental data on which this paper is founded. I hope to deal more fully with this subject, and to consider the influences, &c., which may modify this reaction.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING OCTOBER 31ST, 1887.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, November 7th, 1887.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 182 samples examined were clear, bright, and well filtered.

The water-supply to the Metropolis has been characterised, for several months past, by the smallness of the

nearly always inconsiderable proportion of organic matter which it contains. Thus, during the months of July, August, and September, the mean proportion of organic carbon present in the Thames-derived supplies, was 0·136 part in 100,000 parts of the water, corresponding to appreciably less than one-quarter of a grain of organic matter per gallon, or to less than $\frac{1}{3000}$th part of 1 per cent.

The supply during the past month was found practically identical in character with that of the preceding three months. All the samples, alike from the Thames and the Lea, were free from turbidity, and unexceptionable in respect to colour; while the proportion of organic matter present was but small, and very uniformly so, in the different samples examined. Thus the maximum proportion of organic carbon in any one sample was 0·151 part in 100,000 parts of the water; while the mean proportion present in the Thames-derived supplies, *i.e.*, 0·137 part in 100,000 parts of the water, was identical with the mean for the previous three months. With the coming on of the rainy season, however, it is not to be expected that the present exceptional smallness of the proportion of organic matter, and degree of freedom from colour-tint, will continue.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN,

AND ON THE

CHEMICAL STRUCTURE OF THE TWO LATTER BODIES AND THEIR DISSOCIATION IN THE ATMOSPHERE OF THE SUN.

By Professor A. GRUENWALD.

(Continued from p. 202).

FROM the weighty and remarkable relations and characteristic numerical data deduced, not from single rays but from a comparison of entire series of numerous rays of oxygen, watery vapour, and hydrogen, there follows, according to the fundamental theorem (I.) very simply the chemical structure of oxygen in the interval in which it emits the elementary line spectrum. Let H′, O′, *b*′, O″, *b*″, *c* be the substances which, in a combined state within oxygen, emit the above homonymous groups of rays (H′), (O′), (*b*′), (O″), (*b*″), and (*c*), and let [H′], [O′], [*b*′], [O″], [*b*″] and [*c*] be the volumes which they occupy in a volume-unit of oxygen. We have then the equations :—

$$[H'] = \tfrac{1}{2}, [O'] = \tfrac{1}{2};$$
$$[b'] + [O''] = [O'] = \tfrac{1}{2}$$

and according to theorem (I.) and with reference to the facts under 4β :

$$\tfrac{8}{9}[b'] = \tfrac{4}{5}[O''] = \tfrac{2}{3}[O'] = \tfrac{1}{3}$$

whence—

$$[b'] : [O''] = 4 : 5$$

and—

$$[b'] = \tfrac{4}{9}[O'] = \tfrac{2}{3}[O''] = [O''] = \tfrac{4}{5}[O'] = \tfrac{2}{7}.$$

Further—

$$\tfrac{4}{5}[O''] = \tfrac{4}{5} \times \tfrac{2}{7} = \tfrac{8}{14}$$

the space which O″ occupies in watery vapour within the oxygen ; then—

$$[b''] + [c] = [O''] = \tfrac{2}{7}$$

and according to theorem (I.), on account of the facts given under 4γ—

$$\tfrac{11}{21}[b''] + \tfrac{8}{9}[c] = \tfrac{4}{5}[O''] = \tfrac{8}{14},$$

whence again—

$$[b''] : [c] = 4 : 5,$$

and—

$$[b''] = \tfrac{4}{9}[O''] = \tfrac{4}{7} \times \tfrac{2}{7} = \tfrac{10}{21}[c] = \tfrac{8}{9}[O''] = \tfrac{8}{18}$$

The chemical structure of oxygen in the above-mentioned interval of temperature is consequently expressed by the chemical volume formulæ—

$$O = H'.O', \quad O' = b_4.O''_5, \quad O'' = b_4 c_5$$
$$O = H'.[b_4 O''_5] = H'.[b_4.(b_4 c_5)_5].$$

That is—

"Oxygen in its simplest molecular condition is a compound of the modified hydrogen, H′, which is emitted by the II.nd so-called compound line spectrum of hydrogen in equal volumes with a substance, O′, without condensation. The latter, O′, is a compound of four volumes of the pentavalent (nitrogenoid) element *b* of hydrogen in a peculiar state of chemical condensation with five volumes of a substance, O″, which again consists of four volumes of the primary element *b* (though in a chemical state different from the former), with five volumes of a new primary substance, *c*, as yet unknown.

As I have here ascertained in a mathematico-spectroscopic manner the chemical structure of H and C, I should also be in a position to determine the chemical structure of the so-called elements, nitrogen and carbon, by means of my chemical theory of perturbations if eminent spectroscopists had placed at my disposal complete and trustworthy lists of the wave-lengths of ammonia, NH_3, and methan, CH_4, at a low temperature of the electric spark (so as to avoid their dissociation) or the absorption spectra of these gases. These spectra must extend in the ultra-violet part far down to the respective wave-lengths 1728×10^{-7} and 1383×10^{-7} and possibly still lower.

As regards nitrogen, I have hitherto only succeeded in showing that it, in its simplest chemical condition, is (like oxygen) a compound of the "modified hydrogen H′, in equal volumes with a substance, N′, without condensation, and that the latter substance, N′, must have an entire large group of atoms in common with oxygen, since a group of more than 40 N rays (*i.e.*, their wave-lengths) can be converted by multiplication with the factor $\frac{4}{5}\frac{7}{6}$ into a group of corresponding O rays, that is their wave-lengths.

The volume-formula of nitrogen will very probably have the form of that of oxygen, but with lower indices, since the atomic weight of nitrogen (14) is smaller by 2 than that of O (16).

In carbon also I have been already able, by a mere comparison of its spectrum with the spectra of watery vapour, H and O, to ascertain the existence of the primary matter *b* in at least two different chemical conditions as well as the presence of the primary matter *c*, which is also contained in oxygen.

5. *α*. In the experiments which I instituted upon the spectrum of water to ascertain the reduction factor belonging to the body *a* in hydrogen (0·6336 or approximately $\frac{1}{1}\frac{9}{6}$), I observed that this factor is indeed the mean or chief reduction factor of the four atoms in H which are combined with the substance *b*, but that also special factors for reduction to the water spectrum belonged to each of these four atoms. Of these I succeeded in detecting two, namely, $\frac{3}{4}$ and $\frac{6}{7}\frac{5}{5}$, and in verifying them, at least in as far as the well-known spectrum of H_2O could be compared.

If, therefore, λ is the wave-length of a H-ray of the elementary line spectrum derived from a substance, *a*, in H, then 0·6336 λ (empirically $\frac{1}{1}\frac{9}{6}\lambda$), $\frac{3}{4}\lambda$, and $\frac{6}{7}\frac{5}{5}\lambda$, are, with a near approximation, three different wave-lengths of the H_2O spectrum if the latter is sufficiently known.

β. If, on the other hand, λ is the wave-length of a H-ray emitted from a substance, *b*, existing in H in combination with *a*, then, according to 2, not merely $\frac{3}{4}\lambda$ must be a wave-length of the H_2O spectrum, but according to 4*β* (respectively 4*γ*) $\frac{4}{5}\frac{8}{1}\lambda$ and $\frac{7}{8}\frac{9}{0}\lambda$ must be two wave-lengths of the O spectrum. Further, $\frac{2}{3}\frac{3}{4} \times \frac{4}{5}\frac{8}{1}\lambda$ and

$\frac{1}{4}\lambda \times \frac{1}{8}\lambda$ must be two wave-lengths of the H_2O spectrum, and be capable of recognition, provided that the elementary oxygen spectrum is sufficiently well known, which is unfortunately not the case as regards very feeble rays.

With the above we come into possession of mathematico-spectroscopic criteria for hydrogen rays, which possess an evident similarity with chemical reactions for the detection and recognition of bodies.

(To be continued).

AIR-TIGHT TAPS.

By ARNOLD EILOART, B.Sc. (Lond).

Many forms of these taps were invented by me early in 1885, and several of them were exhibited in the Inventions' Exhibition that year; but as I find (*Chem. Soc. Journ.*, see below) that my earliest form, which is not the best, is still in use, it is necessary to say that the best form is that shown at Fig. I.

Here the plug of the tap has two grooves, G G, running round it, and is used with an ordinary socket, S. These grooves, filled with liquid, check transfer of gas between interior and exterior of tap, and if, through bad grinding, such transfer takes places, it is at once detected by bubbles in the liquid. They may be supplemented by vertical grooves joining them, in opposite quadrants of the plug-circumference, to stop passage of gas round the plug when the tap is turned off.

There was at first a little difficulty about filling the grooves: the outlets, A and B, of the tube, A B (see sketch), —or the vessels with which A B communicates—are closed. The finger closes C, and mercury moistened with glycerin

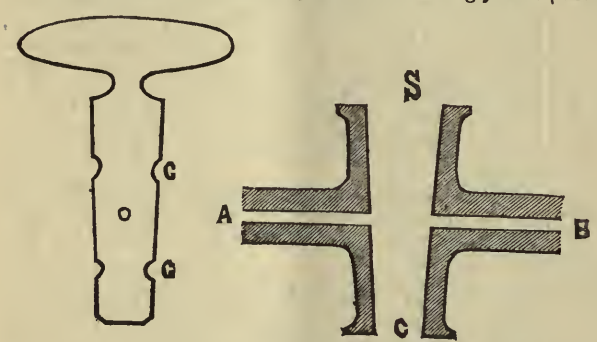

Fig. I.

is poured on to it; the plug is then put in, pushing the finger away; a little liquid runs towards A B, but very little, because there is no exit for the air in these tubes; so the liquid rises further and fills the upper groove as well as the lower.

The earlier form referred to above is shown at Fig. II. In this case the plug is an ordinary one, but the socket is closed below and cupped above to receive the liquid at c and c.

This was my first form, instructions for making samples of which I took to Mr. Cetti, and to which the following extract refers:—"The taps employed are those known in this country as Cetti's patent" (*Chem. Soc. Journ.*, ccxcvi., p. 611). (The text is accompanied by a diagram of Form II). But there can happily be no dispute about originality in this case, for I am assured that the attribution of the invention to Mr. Cetti will not now receive any public support from him, as a letter of his, following on representations by me, offers to place my initials on every tap, and to give me half the profits thereon, thus acknowledging in the most practical way its origination by me.

More important is the consideration of the relative merits of the forms I. and II. In form II. it will be seen that:—

(*a*) It can only be used in a position nearly vertical.
(*b*) If the plug "sticks" it cannot be tapped out from below.
(*c*) If too much liquid be placed in the socket below the plug the latter will not fit tightly if too little air remains.
(*d*) It is more expensive than I.

Adopting form I. any tap may be made air-tight for a few pence by grinding grooves in its plug.

For these reasons I have ventured to give the preference to form I. Samples of it were made for me by Mr. Hicks, Instrument Maker, Hatton Garden.

Leipzig, Nov., 1887.

ON THE EFFECTS PRODUCED BY SMALL QUANTITIES OF BISMUTH ON THE DUCTILITY OF SILVER.

By Surgeon-Major J. SCULLY, Assay Master, Calcutta

It is well known that alloys of silver and bismuth, in certain proportions, are brittle. In Dr. Percy's valuable work on Metallurgy (Silver and Gold—Part I.) it is stated that alloys of silver with bismuth, in the proportion of 50 per cent and 33 per cent of the latter metal, are brittle; while an ore of silver and bismuth, called Chilenite, in which bismuth occurs only to the extent of 14·4 to 15·3 per cent, is said to be malleable. The least amount of bismuth, however, which will injuriously affect the ductility of silver, for example, in such an operation

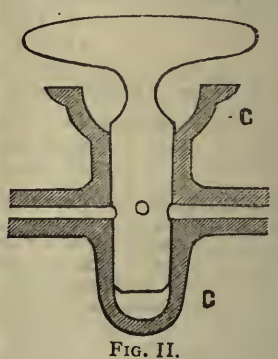

Fig. II.

as the lamination of silver bars for coinage, does not, so far as I am aware, appear to have been experimentally investigated. It may here be mentioned at the outset that an alloy of silver and bismuth may, by careful hammering, be extended considerably, so as to pass muster as malleable; although, if subjected to lamination by means of steel rolls, the same alloy will crack at the edges and thus show a deficient ductility, as compared with pure silver or some silver-copper alloys. It is to the deficiency in ductility, as tested by rolling, of silver containing only very small proportions of bismuth that I here wish to call attention.

My attention was first prominently directed, about two years ago, to the injurious effects caused by small quantities of bismuth in silver by the circumstance that some silver bullion, in the shape of English refined bars of as high a fineness as 990 per mille, proved so brittle as to be unfit for mintage. Attention was first attracted to this matter by the peculiar behaviour under assay of the granulated samples taken from this silver after melting. The appearances noticed under assay will be referred to presently, but they led to the bullion being at once tested

for brittleness. A bar, about 21 inches long, 2·25 broad, and 1 inch thick, was hammered out at one end without cracking, but on being passed through the rolls it cracked badly at the edges and was pronounced to be "brittle," in the Mint sense of the term. The bullion was then remelted in five plumbago pots, and a partial refinement of it attempted in the ordinary way with nitre, about 8 to 10 lbs. of this salt being used for each pot. The resulting silver bars were not appreciably improved by this treatment; hammering again proved an inconclusive test, but a bar of the size I have mentioned broke in two by merely dropping on the floor of the melting-room.

In the meantime the assay had shown that the brittle bullion contained bismuth, and that this was the only substance present likely to be the cause of brittleness. The Indian process of assaying silver has been described by Dr. Busteed in the *Journal of the Asiatic Society of Bengal* (1870, Part II., p. 377), and a brief abstract of this paper is given on p. 292 of Dr. Percy's work before mentioned. The main features of the process may here be briefly recapitulated for the purpose I have in view. A fixed weight of the silver bullion to be assayed is dissolved in an assay bottle, by means of nitric acid aided by heat; the solution is diluted with water and an *excess* of hydrochloric acid is added, to precipitate all the silver present as chloride. The silver chloride having been caused to aggregate and settle by vigorous shaking, the bottle is filled up with water, and the supernatant fluid is subsequently syphoned off, to remove all the now dissolved matter which may have been contained in the bullion. Under these conditions of solution, precipitation, and dilution with water, chemists will readily understand that even a small trace of bismuth, if it be in the silver, will reveal its presence by the partial formation of insoluble oxychloride of bismuth. Now, in the assay of the brittle bullion under consideration, solution in nitric acid had been readily and completely effected by the aid of heat; antimony and tin were consequently absent. After the addition of water and hydrochloric acid, however, the solution in the assay bottles could not be cleared by shaking; the bulk of the silver chloride collected at the bottom of the bottles, but the supernatant fluid remained turbid. Tin and antimony being excluded, only two metals could produce this result in the wet assay of silver, namely, mercury and bismuth. To determine which of these is the interfering metal it is only necessary to note the effect of solar light on the silver chloride formed; when mercury is present the silver chloride maintains its pure white colour unaltered, while in the presence of bismuth the chloride immediately acquires the well-known purple colour under the influence of daylight. Our assays, then, being turbid after precipitation and yet the silver chloride blackening readily under the influence of daylight, it was evident that bismuth was present. The turbidity produced was due to the partial formation of bismuth oxychloride; and this compound diffusing itself in its characteristic manner through the solution had broken up part of the silver salt into very fine powder, so that some hours had to elapse before the supernatant fluid cleared by the gradual subsidence of both bismuth oxychloride and the finely divided silver cloride. The assay was of course thus rendered unreliable, since the silver chloride to be weighed, and on which the calculation of the fineness rested, was contaminated with bismuth oxychloride. A cupellation assay of this bullion was at once had recourse to for ascertaining its fineness.

So far, then, this tender of silver bullion seemed to establish the following points:—

1. Silver bullion of as high fineness as 990 per mille is rendered unfit for coinage purposes by an amount of bismuth which, in this particular case, could not possibly have exceeded 1 *per cent*, and was probably less than that proportion.

2. Hammering a bar of silver bullion is not a good test for detecting brittleness, as far as mint purposes are concerned.

3. The toughening of silver bullion 990 fine, and containing only a small amount of bismuth, by the aid of nitre in plumbago melting-pots, is not readily effected.

4. The presence of a trace of bismuth in silver of high fineness is immediately detected in the ordinary course of assay by the Indian method, but this bismuth interferes with the perfect accuracy of the results obtained by that process.

A comprehensive research seemed therefore called for to elucidate the whole subject, and the necessity for this investigation has since been emphasized by the fact that silver bullion contaminated with bismuth has frequently found its way to the Mint since its first discovery here. The points to be investigated seemed naturally to group themselves under the following heads:—

I. Is our ordinary wet assay of silver susceptible of such easy modification as will enable us to obtain perfectly accurate results by it, in presence of bismuth, without having recourse to the confessedly less accurate assay by cupellation? And, how may small quantities of bismuth in silver be readily estimated with the despatch indispensable for mint operations?

II. What is the smallest amount of bismuth in silver that will render it unfit for coinage, when present in bars of the Indian standard fineness of 916·6? And, what is the amount of bismuth that may be tolerated in such bars without materially injuring their ductility?

III. How is silver bullion containing bismuth, which may be tendered to the Mint, to be dealt with, supposing that establishment accepts any metal that is brittle; and how is the presence of bismuth in refined bars to be accounted for?

I. As the purity of the bismuth to be used in the experiments now to be detailed was a matter of first importance, I may briefly mention the steps taken to ensure the purity of the metal. Refined bismuth was dissolved in nitric acid, precipitated as basic nitrate by diluting largely with distilled water, the nitrate digested in solution of caustic potash, and then well washed, dried, and reduced by heating with charcoal in a clay crucible. A series of synthetical assays, made by dissolving together pure silver and pure bismuth, the latter in the proportion of from 1 to 5 millièmes, showed that our ordinary process of assay, under such conditions, gave unreliable results, there being a surcharge, or higher report than should have been obtained, which varied from 0·7 to 2·7 mills., when the proportion of bismuth was from 3 to 5 millièmes. A modification in our process of assay was evidently required if it were to be used for determining the fineness of silver bullion containing bismuth; and the necessary steps to this end were, after repeated experiment, found to consist in adding the smallest possible amount of hydrochloric acid for the precipitation of the silver, and increasing the amount of nitric acid in which it was first dissolved. We use ordinarily for the precipitation of an assay pound of silver 5·4 c.c. of hydrochloric acid, of sp. gr. 1075; but 2·5 c.c. of acid of this strength suffices for the complete precipitation of an assay pound of even fine silver; so that we have here at once a means of diminishing the tendency of any bismuth in the silver to form insoluble oxychloride. If, in addition to diminishing the amount of hydrochloric acid, we added a considerable excess of nitric acid to the solution (which acid would not in any way interfere with the silver chloride formed), all risk of the partial formation of insoluble bismuth salts seemed removed. This in fact has proved to be the case, and the successful modified process for the assay of silver containing bismuth is as follows:—

The assay pound of silver bullion containing bismuth is dissolved in 5·5 c.c. of nitric acid, sp. gr. 1200, with the aid of heat, about 5 ounces of water are added, and then 10 c.c. of nitric acid, sp. gr. 1320. The silver is now precipitated by the addition of 2·5 c.c. of hydrochloric acid, and after vigorous shaking the supernatant fluid will be found perfectly clear, and it will remain so when the bottle is filled up with water, all the bismuth

present being in solution. Whenever samples of silver now show the presence of bismuth during the assay, a fresh set is taken up and worked by the modified process, the delay thus caused not amounting to more than a few minutes. It may be mentioned here that all our assays are reported to one-tenth of a millième (0·1 per mille).

Having thus ascertained the presence of bismuth in silver bullion, and put in practice a modification of the assay process which renders us indifferent to its presence, it is still of importance to ascertain the exact proportion of bismuth which is present in the bullion, and, to be of practical use for mint work, this determination must be effected rapidly and as simply as possible. The ordinary directions given for the separation of bismuth in the presence of silver, by first removing the latter as chloride and then precipitating the bismuth as carbonate, do not, I find, give accurate results when silver is present in such overwhelming proportions as obtain in the cases under consideration.

I have therefore adopted the following plan, which a number of synthetically prepared solutions have proved to give quick and good results, though sometimes the amount of bismuth present is very slightly underestimated. The ordinary silver assay having given a rough visual estimate of the amount of bismuth likely to be present, enough of the bullion is taken to yield a fairly weighable amount of bismuth oxide in the final result. The bullion is dissolved in a small amount of nitric acid, the solution carefully diluted, and an excess of ammonium carbonate at once added, the precipitation being aided by heating. The carbonates of silver and copper at first formed are re-dissolved, and the carbonate of bismuth after a time settles completely at the bottom of the beaker. The contents of the beaker are then passed through a filter, of which the weight of ash yielded by incineration is known, and the carbonate of bismuth on the filter washed quite free of all traces of silver. The filter is then dried, its contents transferred to a porcelain crucible for ignition, the filter-paper being ignited separately, treated with a drop or two of nitric acid to re-oxidise any bismuth oxide reduced by contact with the carbon of the filter, and the ash added to the crucible. From the weight of bismuth oxide thus found, after deducting the weight of the filter ash, the amount of metallic bismuth present in the sample of bullion taken for analysis can be at once found.

There are only two metals likely to interfere with accuracy of the process here described, namely, cadmium and lead; the carbonates of both these metals being as insoluble in excess of the precipitant employed as bismuth carbonate. Cadmium is very unlikely to be found in silver bullion and its consideration may be neglected, but if the presence of lead is suspected the carbonate filtered from the silver solution is dissolved in nitric acid, evaporated down with the addition of sulphuric acid, and the lead sulphate formed (if any) collected and weighed in the usual way. The bismuth is again precipitated as carbonate and treated as before directed. Many experiments have been made with synthetically prepared mixtures of silver, copper, lead, and bismuth, the latter two metals being in very small proportion to the silver, so as to imitate the composition of some refined bars. Ullgreen's plan for the separation of the carbonates of lead and bismuth, by dissolving them in acetic acid and then precipitating the bismuth by means of a lead rod, does not work satisfactorily and requires too long a time for the precipitation.

(To be continued).

Crystalline Glucose.— Seyberlick and Trampebach have obtained glucose in crystals after conversion by means of nitric acid and crystallisation from a slightly alkaline solution. — *Zeitschrift Zucker Industrie* and *Chemiker Zeitung*.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES,

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 215).

The Perforated Crucible.

IN processes in which the use of filter-paper is deleterious or inconvenient, filtrations and ignitions have been made with the aid of the asbestos filter devised by Mr. Gooch, which consists essentially of a felt of asbestos deposited upon perforated surface of platinum.†

The mode of preparing the filter is as follows:—Asbestos of fine, silky, flexible fibre is scraped longitudinally (not cut) to a fine, short down, which is purified by boiling in strong hydrochloric acid and washing by decantation. A platinum crucible, with bottom perforated with numerous fine holes, is fitted to the upturning end of a piece of soft rubber tubing, the other end of which is stretched over the top of a funnel, as shown in Fig. 11, and the neck of

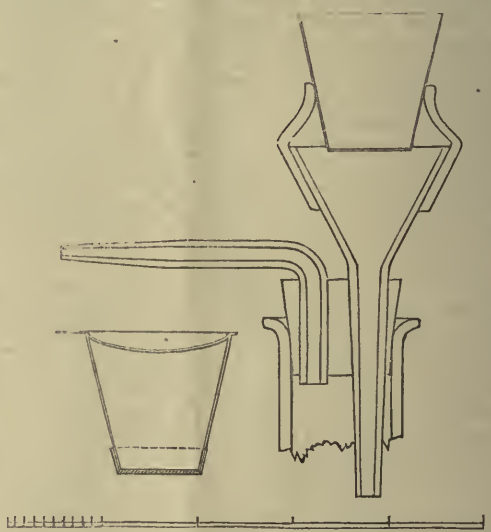

FIG. 11.—PERFORATED CRUCIBLE.

the latter passes through the stopper of a vacuum flask in the usual way.

The vacuum pump having been put in action, a little of the prepared asbestos, suspended in water, is poured into the crucible and the pump is attached, when the asbestos at once assumes the condition of a firm, compact layer, which is washed with ease under the pressure of the pump.

After washing the felt, the crucible with the felt adhering is removed from the funnel, ignited, cooled, and weighed as usual; then set again in place in the rubber holder, taking care that the pump is working, and the liquid to be filtered is poured into the crucible. The crucible, felt, and adhering precipitates are, after washing, ignited, or merely dried, as the case demands, with no further care than the nature of the precipitate itself necessitates.

During the ignition of precipitates, it is frequently necessary to prevent the contact of reducing gases with the perforated bottom; and this is accomplished by placing the crucible either upon a platinum crucible cover or

* From "Mining Industries of the United States."

† For a full description of the process, I refer to Mr. Gooch's original publication in *Proceedings of the Amer. Acad. of Science* (1878), or CHEM. NEWS, xxxvii., 181.

within a second crucible, or, better, by using a form of crucible which is conical in shape and provided with a cap, removable at pleasure, to cover the bottom during ignitions.* When a larger filtering surface than the bottom of a crucible affords is needed, a cone of platinum, perforated and fitted to a rubber seat, is substituted for the crucible.

Sketch of the Various Methods Proposed for the Determination of Phosphoric Acid, and Discussion of the Methods in General Use at the Present Time.

I shall not attempt in this sketch to trace those methods which are not applicable to iron ores, among which may be mentioned the lead, mercury (*Pogg. Ann.*, lxxvi., 218), uranium (Leconte, *Compt. Rend.*, xxix., 55), and tin (*Compt. Rend.*, xxxiii., 385) methods, and that based on the separation and weighing of ferric phosphate and the titration of the iron by solution of permanganate (Raewsky, *Compt. Rend.*, xxiv., 681).

The first step toward an accurate method for the estimation of phosphoric acid in presence of iron was taken when Otto (*Ann. d. Pharm.*, viii., 142, 167), in 1844, suggested its precipitation as $Mg_2(NH_4)_2P_2O_8$ by adding magnesic sulphate to an ammoniacal liquid in which the Fe_2O_3 was kept in solution by tartaric acid.

The separation of this acid from a large excess of ferric oxide was still very difficult, and the results obtained were very inaccurate.

In 1846 Svanberg and Struve (*Jour. für Pr. Chem.*, xliv., 291) discovered the reaction of phosphoric acid with ammonic molybdate, and Rose (*Pogg. Ann.*, lxxvi., 26) confirmed their statements. This, however, was only qualitative.

R. Weber (*Pogg. Ann.*, lxxiii., 137), in 1846, showed the necessity for converting any pyrophosphoric into orthophosphoric acid, and recommended heating with H_2SO_4 to accomplish this result.

About this time Fresenius (*Jour. für Pr. Chem.*, xlv., 258) published the method which is largely the same as that which is now known as the acetate method. It is in substance as follows:—Reduce the iron in the acid solution with Na_2SO_3 until Na_2CO_3 produces a white precipitate; boil off all SO_2, neutralise nearly with Na_2CO_3, add a few drops of chlorine water and excess of sodic acetate; add chlorine water until the liquid is red, boil until it clears, and filter hot. The precipitate contains all the P_2O_5. Dissolve this precipitate in HCl and precipitate the iron by NH_4HO and $(NH_4)_2S$, or precipitate, after reducing with Na_2SO_3, by NaHO, boiling hot, filter, and in the filtrate precipitate with magnesium mixture and ammonia.

He stated that neither citric acid nor sugar possessed any advantage over tartaric acid in preventing the precipitation of small amounts of iron with the $Mg_2(NH_4)_2P_2O_8$.

J. C. Nesbitt (*Jour. Chem. Soc.*, i., 44) claimed that the precipitate of $Mg_2(NH_4)_2P_2O_8$, from a solution containing $MgSO_4$, NH_4Cl, NH_4HO, Fe_2O_3, and Al_2O_3, contained varying amounts of Fe_2O_3 and Al_2O_3 unless the solution was very dilute and contained a great excess of tartaric acid and ammonia; and Fresenius (*Jour. Pr. Chem.*, xlv., 259) stated that at a certain degree of concentration a precipitate was thrown down from a solution containing only Mg_2SO_4, NH_4Cl, tartaric acid, and ammonia.

Rose, a little later, published an account of the various methods for the determination of P_2O_5, and said, among other things, in regard to the precipitate of—

$$Mg_2(NH_4)_2P_2O_8,$$

that the solution, after the addition of $MgSO_4$, NH_4Cl, and NH_4HO, should stand for some hours, and should not be heated above 30°.

The precipitate should be washed (according to Fresenius) with ammonia water, and the presence of a great excess of ammoniacal and other salts, Rose stated, had no influence upon the precipitation. He added that $(NH_4)_2CO_3$ threw down an insoluble double salt of Mg and NH_4, and should not be used instead of NH_4HO, and also that P_2O_5 could not be perfectly separated from iron by $(NH_4)_2S$, for while the FeS contained no P_2O_5, the filtrate deposited iron with the $Mg_2(NH_4)_2P_2O_8$. He also suggested the precipitation of P_2O_5 by $BaCO_3$.

Sonnenschein (*Jour. Pr. Chem.*, liii., 339) first used, about 1850, the molybdate method quantitatively. He used a solution containing 1 part ammonic molybdate and 20 parts HNO_3. Of this solution he used 30 times as much as was necessary to precipitate the P_2O_5, allowed it to stand several hours at a gentle heat, filtered, washed with the precipitant dissolved on the filter in NH_4HO, and then precipitated by Mg mixture.

Ullgren (*Jour. Pr. Chem.*, liii., 33), about the same time, proposed the following method:—A solution of the iron ore in HCl, or of the iron in HNO_3, evaporated to a syrupy consistency with HCl and diluted, was poured into a solution of potassic sulphide and potassic silicate (1 grm. of iron to 5 grms. potassic sulphide and 1 grm. potassic silicate). The precipitate contained MgO, CaO, Al_2O_3, and sulphides of positive metals; the filtrate, potassic phosphate, and sulphides of negative metals. The filtrate was mixed with freshly precipitated $PbCO_3$, filtered and washed with water containing one-tenth its volume of a concentrated solution of $(NH_4)_2CO_3$ and NH_4HO. The filtrate was evaporated to dryness, the mass moistened with HCl, diluted, and filtered from SiO_2. Filtrate contained P_2O_5 and traces of Fe_2O_3, &c. Tartaric acid was added, and P_2O_5 precipitated by Mg mixture as usual. He also suggested adding ferrocyanide of potassium and K_2S to the nitric acid solution of the iron containing tartaric acid, ammonia, and magnesic sulphate, filtering off the precipitate of S and $Mg_2(NH_4)_2P_2O_8$, and fusing with Na_2CO_3, and determining P_2O_5 in the filtered solution, after acidulating with HCl, by Mg mixture.

Kremers (*Pogg. Ann.*, lxxxiv., 77) gave the proper strength of ammonia water for washing the precipitate of $Mg_2(NH_4)_2P_2O_8$ as 3 parts water to 1 part NH_4HO. He said that the precipitate dissolved in all other mixtures.

W. Wicke (*Ann. Ch. Phar.*, xcv., 373) recommended molybdate of lead instead of molybdate of ammonia as a precipitant of P_2O_5.

W. Knop (*Chem. Centr.*, 1857, 691, and 861) stated that pure silicate of potash treated with HNO_3 and ammonic molybdate gave a precipitate similar to that obtained from a small amount of P_2O_5.

Damour and H. Sainte-Claire Deville (*Inst.*, 1858, 69), in 1858, showed that oxide of cerium added to an acid solution of P_2O_5 gave a pale yellow precipitate.

Staedeler (*Ann. Ch. Phar.*, cix., 306) recommended Otto's method, but suggested re-dissolving and re-precipitating the first precipitate of $Mg_2(NH_4)_2P_2O_8$.

A. Lipowitz (*Pogg. Ann.*, cix., 135) suggested the use of a molybdate solution containing 2 MoO_3, 1 tartaric acid, 15 water, 10 NH_4HO, and 15 HNO_3. After adding the precipitant to the solution of iron containing P_2O_5, he heated it to boiling, and weighed the precipitated phosphomolybdate of ammonia on a counterpoised filter, dried at 20° or 30°, or, better, over H_2SO_4. The precipitate contained 3·607 per cent P_2O_5.

H. Struve (*Jour. Pr. Chem.*, lxxix., 321) dissolved the iron in HNO_3 and HCl, evaporated to dryness, re-dissolved in HCl, and filtered from SiO_2, precipitated by NH_4HO, fused precipitate with Na_2CO_3, dissolved in hot water, filtered, and determined P_2O_5 in filtrate by Mg mixture.

V. Eggertz (*Jour. Pr. Chem.*, lxxix., 496), in 1860, recommended the molybdate method. He dissolved MoO_3 in 4 parts NH_4HO, and filtered into 15 parts HNO_3 (1·2 sp. gr.); dissolved the iron or steel in HNO_3, evaporated to dryness, re-dissolved in HCl, added molybdate solution, and set it aside at a temperature of 40°, with occasional stirring for 2 or 3 hours. He filtered the dried precipitate at 95°, and weighed. The precipitate contained 3·74 per cent P_2O_5.

(To be continued).

* This convenient little crucible is made and perforated in the best possible manner by J. Bishop, of Sugartown, Pa.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, November 7, 1887.

Warren de la Rue, Esq., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

The following gentlemen were elected Members:—Edmund Gosse, M.A., and F. H. Lewis.

The special thanks of the Members were returned to Mr. W. Resbury Few for his present of a large Photograph of the Nebulæ of Orion, the property of his late father, Mr. Charles Few.

The special thanks of the Members were returned to Mr. William Anderson for his present of a Double Acting High Vacuum Pump.

The special thanks of the Members were returned to the Rev. John Macnaught for his present of £50 for improvements in the Lecture Theatre.

The presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Exercises in Quantitative Chemical Analysis: with a short Treatise on Gas Analysis. By W. Dittmar, LL.D., F.R.S., F.R.S.E. Glasgow: W. Hodge and Co.

Among the many chemical treatises for the use of students which have appeared within the last twenty years, the work before us may justly claim an exceptionally high rank. No one can say that its teachings, however correct, are mere reproductions of matter which have appeared again and again in previous works.

From the generality of laboratory text-books it differs by the exposition of quantitative electrolysis, a method which is coming more and more into use in the separation and the determination of metals. We find also instructions for the performance of Kjeldahl's method of determining nitrogen, of which, in these days, the student cannot well afford to remain ignorant. The processes of Schlœsing and of Walter Crum for determining nitric and nitrous acids are also described.

Perhaps the most important feature in the work is the section on gas analysis,—a series of methods now indispensable not merely in many departments of abstract research, but in technical chemistry. Without it the composition of chamber, furnace, and chimney gases could never be studied, and some of the most important industrial operations would be left in darkness.

In the separation of iron and alumina Dr. Dittmar recommends the caustic potash method. For separating nickel and cobalt the author mentions the processes of Liebig and Rose as now superseded, and describes the nitrite process (Stromeyer's), the nitroso-β naphthol method (of Ilinski and Knorre), and the Dirvell-Clark phosphate process—which he pronounces the most elegant of all the known separations of these two metals, but does not feel free to decide as to its relative exactness.

In the assay of iron and copper pyrites for sulphur he prefers the caustic potash method, which was worked out in his laboratory by Mr. John M'Arthur. He weighs out 5 grms. pure caustic potash, free from sulphate, and 3·5 grms. nitre, and melts them in 1 c.c. of water in a large basin, either of silver or—preferably—of Dittmar's alloy (91 Ag, 7 Au, and 2 Ni). He then places 0·5 grm. of the sample on the surface of the mixture, stirs up with a silver rod, and heats gently until the water is expelled and then to fusion, stirring constantly to prevent loss by spirting. He lets cool, dissolves in water, filters off iron oxide, washes in hot water until all alkali is removed, acidifies with HCl, boils for a few minutes, and adds excess of barium chloride. He points out a fact not universally known, that prolonged ignition of barium sulphate in a platinum crucible produces an appreciable quantity of barium sulphide.

For pyritic shales or coals he prefers Eschkas's method, which, however, if applied to ordinary pyrites, seems to give results from 1 to 2 per cent too low, so consequently inadmissible. He gives instructions for the determination of arsenic in pyrites. This used to be a somewhat sore point with alkali manufacturers. At least we have heard of one important firm who, in language more emphatic than courteous, interdicted their chemist from in future determining arsenic in samples of pyrites.

The latter part of the book contains promiscuous exercises in applied analysis, such as the analysis of sea water, of potash salts, of cast-iron, guano, milk, soap, tanning materials, &c.

We should fail to convey a fair idea of Dr. Dittmar's work if we made no reference to his peculiar point of view. This is conveyed in the second sentence of his instructions for weighing:—"But a mere knowledge of the method is not sufficient; you must practise the art for hours and hours until you have it at your finger-ends." This idea is generalised in the preface. The author says, meeting a supposed objection, "To some of my readers the tone of the earlier exercises more especially may savour a little of mechanical drilling. Why tell the student so minutely what he has to do, and hinder him from exercising his own ingenuity?" To this supposed objection he replies,—and in our opinion with great justice,—"Some ten years ago, if a book like the present had been placed before me, I should have asked this question myself. But I have since come to modify my views. The technicalities of quantitative analysis are the very things which the student is not likely to find out by himself. He had better be drilled into doing them correctly. . . . He must be made alive to the fact that no amount of scientific knowledge will enable a man to get through a qualitative analysis successfully unless he has the 'canning' as well as the knowing, and unless he attends to all those little practical details which to him at first sight may appear to be irrelevant." With these views we cannot but agree, and as the work is carried out accordingly we feel fully justified in giving it our hearty recommendation.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., July, 1887.

Determination of Phosphorus in Iron and Steel.—P. Vorwek.—From the *Chemiker Zeitung*.

Influence of Foreign Bodies upon the Properties of Refined Copper.—W. Stahl.—The author concludes that the spitting of copper is not produced in all cases solely by an escape of sulphurous gas, but sometimes also by the furnace gases which dissolve in the melted copper and escape at the moment of its solidification. Certain refined coppers, free from arsenic and lead, absorb gases, even before the reduction has been pushed to 0·07 and 0·05 per cent of oxygen, that is to the point where the metal acquires its maximum tenacity; these coppers, by reason of the porosity which results from the escape of gases at the moment of solidification, are much less fit

or mechanical uses than coppers which are denser, though less pure. Small quantities of lead (about 0·25 per cent), of arsenic (0·4 per cent and even more), and in coppers free from lead and bismuth, traces of phosphorus act favourably upon the tenacity, the malleability, and the ductility of copper.

Use of Oxalic Acid in Qualitative and Quantitative Analysis.—C. Luckow.—This memoir, which is from the *Chemiker Zeitung*, will be inserted at some length.

Determination of Organic Substances in Water.—Dr. A. Koebrich.—This paper also will be inserted at length.

Detection of Traces of Aldehyd in Alcohols.—For the detection of aldehyd in alcohol or spirits they are reduced by distillation so as to concentrate the aldehyd in about one-fifth of the original volume. The product is passed into a capsule of porcelain, the white bottom of which renders coloured reactions more perceptible. There is then poured under it, through a funnel, the orifice of which rests upon the bottom of the capsule, a solution of diphenylene-diamine hydrochlorate. The yellow colour formed at the zone of contact of the two liquids disappears on contact with alkalies, and re-appears on acidulating the liquid.

New Methods for Detecting the Artificial Colouration of Wines.—Jos. Herz.—This paper will be inserted in full, if possible.

Analyses of Old Wines.—Dr. J. Moritz (*Chemiker Zeitung*.—The results are given in the form of tables.

Differences between Natural Butter and its Artificial Substitutes. — E. Scheffer. — The solubility diminishes regularly with the increase of the proportion of grease mixed with the natural butter.

New Determination of Tannin. — H. Dieudonné (*Chemiker Zeitung*).—Already noticed.

Determination of Fatty Acids in Soaps. — B. Schulze.—Already noticed.

Proportion of Alkaloids in Narcotic Extracts.—E. Dietrich.

Determination of Colchicine.—A. Kremel.

Assay of Coca Leaves.—Kœhler.

Assay of the Purity of Cocaine Hydrochlorate.—O. Anrick.—These four papers have a purely pharmaceutical interest.

Determination of Morphine in Opium and its Preparations.—O. Schlickum.—For the assay of opium 3 grms. of the powdered sample are digested in a closed vessel with 15 grms. alcohol at 70 per cent and 15 grms. of distilled water. The mixture is agitated frequently for twelve hours, and is then poured upon a filter. The filtrate is weighed, a few drops of ammonia are added until the reaction is distinctly alkaline, and it is then boiled down to half its volume. It is then made up to its original weight with distilled water and filtered again; 21¼ grms. of this filtrate are treated with 0·4 grm. ammonia at 10 per cent, and 5 grms. ether; it is well shaken up several times during a couple of hours and let settle. After having drawn off the ethereal layer with a pipette as completely as possible, the precipitate is thrown upon a small weighed filter, washed twice with 2 c.c. of distilled water, and then dried at 100° C. until the weight is constant. The weight of the morphine thus separated should not be less than 0·2 grm.

On the Tungsten-Steel Industry.—The proportions of tungsten introduced into steel range from 2 to 8 per cent. It is added when the steel is in full fusion, and the metal is still kept liquid and well agitated for half an hour.

Colouration of Polished Brass.—E. Ebermayer.—The articles are passed into boiling baths composed of various salts. According to the duration of the contact the shades obtained are more or less intense.

The Aromatic Hydrocarbons in the Mineral Oils of the Caucasus. — Markownikoff. — From *Liebig's Annalen*.

Manufacture of Maize-Starch in America.—G. Archbold.—From the *Journal of the Society of Chemical Industry*.

Chemical Assay of Tissues.—The solubility of animal fibres in strong alkaline liquids, and the insolubility of vegetable matter under the same circumstances is a summary way of detecting wool in presence of vegetable matter. Mineral acids and acid salts, on the contrary, have no action on animal fibres, whilst they gradually carbonise vegetable fibres. [Both these latter propositions must be occepted with reservations]. Animal fibres are coloured yellow by nitric acid, and turn red if heated in Millon's reagent (mercuric and mercurous nitrate). These phenomena are not produced with vegetable fibres. Vegetable fibre (cellulose), as well as silk, dissolves readily in ammoniacal copper oxide, and the former can be re-precipitated by a number of salts, by sugar, and by gum. Silk can be re-precipitated only by the aid of weak acids. According to Peligot a solution of copper oxide in ammonia, well fitted for reacting on tissues, may be obtained by dissolving in a little ammonia with access of air, copper filings, or electrolytic powder of copper. Nitric acid without apparently attacking vegetable fibres dissolves silk in time and colours wool yellow. According to Schlossberger the ammoniacal solution of nickel oxide dissolves silk very readily without attacking cotton. As wool always contains sulphur it may be recognised as follows:—Lead hydroxide, dissolved in caustic alkali, blackens when brought in contact with wool. This test is worthless if sulphured silk is simultaneously present. Liebermann prepares a saturated aqueous solution of magenta and adds caustic alkali by drops until the colour has disappeared. The liquid is then filtered and the tissue in question is immersed in the filtrate and washed in much water. The wool in the tissue then appears coloured red, whilst cotton remains colourless. Silk behaves like wool. Persoz finds that silk dissolves readily in a hot solution of zinc chloride at 60° B. On this fact he founds a method of determining the silk quantitatively, which has been subsequently developed. Three samples of the cloth (2lbs. each) are boiled in 200 c.c. of hydrochloric acid at 3 per cent in order to remove the dressing, and they are then carefully washed and pressed. In case of coloured goods cotton very quickly loses its colour, wool is stripped more slowly and silk more slowly still. Two of the swatches thus prepared are immersed in a boiling solution of zinc chloride containing 850 parts of water, 1000 zinc chloride, and 40 parts zinc oxide. The difference of weight before and after the treatment shows the quantity of silk found in the tissue. On heating the third swatch in 60 to 80 c.c. of caustic soda (at sp. gr. 1·02) for fifteen minutes at 100°, washing and drying the quantity of wool, is shown by the difference of weight before and after treatment. In his work on the structure and assay of silks Hœnnel gives another method for the qualitative and quantitative determination of the different fibres. Mulberry silk behaves quite differently from wild silks with a solution of chromic acid. If a sample of the former is plunged into a solution of chromic acid saturated in the cold and then diluted with an equal volume of water and boiled for one minute, the silk dissolves completely. Wild silks remain apparently unaltered after boiling for two to three minutes. Wool behaves in this solution like mulberry silk. Different kinds of silk behave differently with a boiling and moderately strong solution of caustic potassa in which true silk is attacked more rapidly than adulterated silks. [It does not appear whether this expression refers to weighted silks, or by an abuse of language to wild silks]. To separate wool from mulberry silk the best method is to treat the swatch with boiling hydrochloric acid, in which silk dissolves rapidly and wool swells up, but without dis-

solving. This method may also serve for the quantitative determination of the fibres forming the tissues. To distinguish wool from "adulterated" silks the above-mentioned solution of chromic acid may be used. On heating in this solution wool dissolves very rapidly, whilst the adulterated silks resist. In this manner may be distinguished a mixture of cotton, wool, mulberry silk, and Jamamai silk as follows:—On boiling this mixture in hydrochloric acid the silk dissolves in half a minute; on boiling for two minutes in strong hydrochloric acid the Jamamai silk dissolves. In the residue the wool is dissolved by caustic alkali and the cotton remains unchanged. Cellulose, if treated with acids, is partly transformed into sugar. By taking advantage of this fact, and of the property of sugars to yield beautiful colourations with sulphuric acid and naphthol or thymol, Molisch has devised a new method for distinguishing vegetable and animal fibres. To eliminate every error the swatch should be repeatedly boiled with water to remove any gum, sugar, &c., present in the dressing. In case of wool care must be taken that it does not contain lice or burrs. Molisch then places in a test-tube 0·01 grm. (about) of fibres well boiled and washed in much water; he adds 1 c.c. of water and several drops of an alcoholic solution of naphthol at 15 to 20 per cent, and the liquid is then mixed with an equal volume of concentrated sulphuric acid. If the swatch contains vegetable fibres they dissolve rapidly, and the liquid, on stirring, takes a deep violet colour. If the fibres are of animal origin the liquid takes a more or less intense yellow, even up to a reddish brown. If we use thymol instead of naphthol we obtain, under the same conditions, a colour midway between vermilion and carmine. Silk behaves like the animal fibres. Dyes do not interfere with this reaction. According to A. Lidoff raw silk dissolves rapidly in melted oxalic acid, cellulose slowly, and wool not at all.—*Technik.*

On the Distribution of the Nitrifying Organism in the Soil.—R. Warington.—From the *Journal of the Chemical Society.*

Examination of a Commercial Quinine Sulphate containing Cinchonidine and Hydroquinone.—J. E. de Vrij.—This paper does not admit of useful abstraction.

Industrial Preparation of the Benzoyl Greens.—Dr. O. Muhlhauser.—An account in detail of the manufacture of malachite green, brilliant green, and acid green.

Contributions to the Metallurgy of Bismuth.—Ed. Matthey.—From the CHEMICAL NEWS.

Physical Properties of Manganese Steel.—W. Barrett.—From the CHEMICAL NEWS.

ERRATUM.—P. 215, foot of col. 1, *for* "W' the weight of ore+water," *read* "W' the weight of the flask + ore + water."

MEETINGS FOR THE WEEK.

MONDAY, 28th.—Medical, 8.30.
TUESDAY, 29th.—Institution of Civil Engineers, 8.
WEDNESDAY, 30th.—Society of Arts, 8.
—— Royal, 4. (Anniversary).
THURSDAY, Dec. 1st.—Chemical, 8. Ballot for the election of Fellows. "On the Supposed Third Nitroethane," by Prof. Dunstan and T. S. Dymond. "Researches on the Laws of Substitution in the Naphthalene Series," by Prof. H. E. Armstrong, F.R.S.
FRIDAY, 2nd.—Geologists' Association, 8.

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". . . . Likely to be useful to those actually engaged in applied Chemistry, as well as to the Student."—*Journal of Gas Lighting.*
E. & S. LIVINGSTONE, Publishers, Edinburgh.

UNIVERSITY COLLEGE, LIVERPOOL.
SHERIDAN MUSPRATT SCHOLARSHIP.
The competitive Examination for the above Chemical Scholarship will be held at the College on December 8th and following days. The Scholarship is of the annual value of £50, tenable for two years. For fuller particulars regarding subjects of examination and conditions of tenure apply to the College Registrar. Intending candidates must send in their application on or before Thursday, December 1st. Preference is given to candidates under twenty-three on Jan. 1, 1888, though others are not ineligible.

PROF. A. E. FOOTE, of Philadelphia, commences packing the great collection of Minerals and Scientific Books that he has displayed at the American Exhibition, Nov. 29th. As, however, he has just received by express from America a number of his very cheap educational collections, which he can furnish at the very low prices mentioned below, sale continued till December 7th.
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THE ALLEGED SYNTHESIS OF GLUCOSE.

By SAMUEL E. PHILLIPS, F.C.S.

In my "Old or New Chemistry, which is Fittest for Survival?"* I have indicated three properties by which aldehyds form a generic series:—

1st. They dedouble, with $-2HO$.

2ndly. They re-assimilate the 2HO in the condensed radical.

3rdly. They form hydro-compounds by assimilation of 2H.

Benzoin and hydrobenzoin are typical of this series, and hence some are called "oins" with a distinctive prefix.

At page 45 the case of glycer-aldehyd is given:—

2 glycer-aldehyd $-2HO =$

$$\left.\begin{matrix}6\\5\\4\end{matrix}\right\} C_{12}H_9O_8, O.HO \text{ the dialdehyd.}$$

$$+2HO = C_{12}H_{11}O_{10}.O.HO\ (a) = \text{glyceroin.}$$

$$+2H = C_{12}H_{13}O_{10}.O.HO\ (b) = \text{hydro-glyceroin.}$$

Now is (*a*) a re-discovery, or is it now identified with having the properties of an optically inactive *glucose?*

If this theory of its genesis be correct, then it would follow that (*b*) should evince the characters of a *mannite*. That these radicals are chemically correct we *do know* from their amides; to wit, that—

$$(a) + \text{ammonia} - 2HO = C_{12}H_{11}O_{10},H_2N,$$

and (*b*) similarly $C_{12}H_{13}O_{10},H_2N$, or their corresponding azins or oximes.

As we have oxy-alcohols and oxy-aldehyds, which have been mostly obscured by modern hypotheses, so it is infinitely plain that their chemical structures and corresponding properties evince a unity of principle which must command attention and ultimate admiration.

Wokingham Road, Reading.

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

A few modifications in the details of manipulation have been introduced since writing the first paper on this subject, which I propose giving on a future occasion. I may just mention here that the addition of only a few drops of cotton-seed oil to 10 grms. of genuine butter-fat give a very cloudy appearance; when the mixture is subsequently treated with carbon disulphide, 10 drops produce a thick, almost black, product.

A matter deserving attention has cropped up recently that I thought it would be interesting to make a special subject of enquiry, so as to make the attack on adulteration more certain and complete.

Evidently all samples of oleo-margarine or butterine do not contain vegetable oils. I am therefore directing attention to the animal products which may be employed in their manufacture, and, on looking for information on the matter of animal oils and fats, I have been fairly surprised at the great blank which our own literature presents.

According to Chateau, who has made a special study of animal fats, the French "graisses" corresponds to the Latin "adeps," and to the English "fat" or "grease." The French "suifs" corresponds to the Latin "sebum" and to the English "tallow." To this portion of the subject I shall refer further on.

The oleo-margarine manufacturer is clearly ahead of our oil experts as to the available materials for butterine manufacture. Only a few days ago I purchased an article sold as butterine and known to be such, as it was supplied as "oleo-margarine," and which consisted of animal fats only. The price paid was sixpence per pound.

When treated with chloride sulphur it turned black after a few hours standing; pure butter turns to a light brownish colour, but does not blacken, and, in order to find an explanation for this curious result, I made a special examination of the different animal fats aud oils within reach. I found that commercial oleic acid thickens and turns quite black; animal oleine turns very dark, the products in both cases being soluble in carbon disulphide. Lard made from the omentum of the pig behaved so much like butter that I feel I should be encouraging a fraud, until I can pronounce definitely on it one way or the other.

As no substance rich in stearine is admissible as a butter substitute, increased attention should be directed to the animal oleines which are now commercial articles. The hard fats, known ordinarily as tallow, are used by oleo-margarine manufacturers for producing the better classes of butterine; the stearine is removed by pressure, the fat being melted and kept at about 80° F.

Only a few days ago my attention was called to an analysis of American lard oil, which consisted approximately of equal parts of oleine and cotton-seed oil. The oleine was not obtained from the fat of the pig.

Fats may be divided into two classes, the *soft* fats being represented by "lard," and the *hard* fats which are represented by "tallow."

Chateau points out that the Greek word *Stear* is used for both kinds of fats, but it is very remarkable that no language in Europe employs the identical term for both kinds of fatty substances.

Confining our attention to fat or grease (Lat. *adeps*, Fr. *graisse*), Chateau says that in usual parlance we give the name "fat" or "grease" to a fatty substance more or less soft, but soft solids at ordinary temperatures,—such are obtained from mammals and birds: it is found in cavities in adipose tissue, and accumulates principally —though in variable proportions—along the surface of the intestines, in the double membrane of the epiploon, around the kidneys, between the flesh and skin, in the lower cardiac region, and other parts of the body.

Chateau says that the taste and smell of these fats are very faint and not disagreeable. Their consistency varies according to the part of the animal from which it has been extracted; under the skin and around the kidneys it is firmer than in the neighbourhood of the movable viscera. The higher or lower fusibility and the softness of the fat depend on the proportion of oleine which these fats contain.

I have no hesitation in saying that these fats referred to by Chateau enter more largely into oleo-margarine than the oleine from hard fats. Their rich and moderately greasy flavour are not at all repugnant; many of them have the taste and flavour of good dripping which collects when meat is being roasted.

Most of these oils or greases thicken and turn black with chloride sulphur, and could not be added to butter without being detected. The nauseating idea is that our alimentary canal is liable to be utilised as a means of emptying Mother Grub's stock-pot; the idea may upset one's power of deglutition, but this appears to be a small matter to be taken into account when compounding artificial butter.

* Which may be had from the author, post free, 2s.

Ammoniacal Copper Sulphate.—Cupric compounds are now used with sucess as a remedy for the *Peronospora viticola*. M. Casthelaz bases his processes on preparing the ammoniacal sulphate extemporaneously in the midst of the copper solutions.—*Moniteur Scientifique.*

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN,

AND ON THE

CHEMICAL STRUCTURE OF THE TWO LATTER BODIES AND THEIR DISSOCIATION IN THE ATMOSPHERE OF THE SUN.

By Professor A. GRUENWALD.

(Concluded from p. 224).

III.

The Dissociation of Hydrogen in the Sun's Atmosphere.

An attentive comparison of the lines of the spectrum of the primary element, *b*, given above, with the corresponding adjacent Frauenhofer lines and those of the chromosphere teaches us that the element *b* must occur in a free condition in the solar atmosphere, and must be identical with helium, of which, hitherto, only one ray was known, D_3 5874·9.

Thereby, as well as by the close agreement of the lines of the *a* spectrum, also given above, with the corresponding lines of the solar spectrum, it is proved that hydrogen occurs in the sun's atmosphere in a state of dissociation.

But if this is the case the constituent *a* must occur not only wherever the dissociation takes place, along with helium, but being the lightest of all gases, it must rise highest above the photosphere in regions which are only exceptionally reached by the much denser helium and the other elements in violent eruption. If this takes place, and if in these very lofty and relatively cool regions helium *b* and the primary matter *a* come in contact, then at the exceedingly low pressure here prevailing we have all the conditions given for the formation of the "modified, ammonioid hydrogen," which emits the second "compound" hydrogen spectrum. Such regions, which correspond with the extreme parts of the corona, will therefore show especially the lines of the second hydrogen spectrum along with those of normal hydrogen.

A gas having the properties above represented seems to be the hitherto unknown corona substance, which emits the only at present known ray 1474 of Kirchoff's scale, or $\lambda = 5315{\cdot}9$ of Angström's, and which I may be here permitted to name briefly "*coronium*." We may therefore possibly assume that the primary constituent, *a*, of hydrogen is identical with this coronium, which is in any case a distinct substance from helium, since the corona line 5315·9 often remains unchanged, whilst at the same time the helium line, D_3, is either expanded or distorted and displaced, displaying Lockyer's forms of motion.

If this supposition is correct, $\lambda = 5315{\cdot}9$ (approximately) must be a wave-length of the above *a* spectrum, which was not detected by calculation solely because the wave-lengths in hydrogen corresponding to the element *a* are not completely known. In this case $\lambda = 5315{\cdot}9$, multiplied by $\frac{2}{3}$, must be converted into a wave-length of the elementary H-spectrum. Now certainly the wave-length $\frac{2}{3} \times 5315{\cdot}9 =$ (about) 3544·0 does not occur in the list of the wave-lengths known at present as belonging to hydrogen, but if we compare the second very rich section of the H_2O spectrum (II. I.) corresponding to the hydrogen spectrum as given by Dr. Hasselberg, it answers in a very satisfactory manner to the criteria (II. 5*a*) for H-rays which belong to the body *a* in hydrogen, since—

$$\tfrac{1}{10} \times 3544{\cdot}0 = 2244{\cdot}5,\ \tfrac{3}{4} \times 3544{\cdot}0 = 2658{\cdot}0,$$

and—

$$\tfrac{9}{10} \times 3544{\cdot}0 = 2646{\cdot}1,$$

deviating only by a few tenths of an Angström's unit (10−7 m.m.) from the corresponding wave-lengths of the H_2O spectrum, 2244·8, 2658 6, 2645·4. The ray at about $\lambda = 3544{\cdot}0$ is therefore a hitherto unknown ray of hydrogen, the existence of which will in future admit of experimental verification, $\lambda = 5315{\cdot}9$ is a wave-length (formerly escaping calculation from the deficiency of data) of the primary element *a*, the latter being therefore probably identical with coronium.

I must not, however, neglect to mention that the line 5317·28 of Dr. Hasselberg's II. hydrogen spectrum lies very close to the corona line 5315·9, and, according to what has been said, will probably be observed in the relatively cooler regions of the corona, far remote from the photosphere. If these two lines are really distinct from each other it should be possible, under favourable circumstances, to observe both simultaneously in the corona, 5315·9 in the hotter region nearer the photosphere, and the other in the cooler region more remote from the photosphere.

Similar is the case with the well-known line of the chromosphere, $\lambda = 4471{\cdot}2$ of Rayet (Lorenzoni's *f*), which deviates only by 0·3 from the adjacent line of that part of the II. hydrogen spectrum which Dr. Hasselberg mentioned in 1884, *i.e.*, the line $\lambda = 4470{\cdot}9$, as well as from the chromospheric line $\lambda = 4712{\cdot}5$, which, like 4471·2, is rather a band than a line, and like the latter is ascribed to *Ce*, but differs only by 0·6 from the nearest line of the II. H-spectrum, 4713·1.

The line 4471·2, which I was inclined to take for a helium line, does not belong to helium, as it does not display the characteristic mathematic-spectroscopic criteria of the helium lines. This is confirmed by the observations made by Prof. Young, August 3rd and 5th, 1872, according to which at the same time when D_3 5015·0, 4571·4, &c., were strongly disturbed, the lines 4471·2, 7055, and the corona line 5315·9 remained unaffected. As regards the approaching total eclipse of the sun, I would call special attention to the circumstance that, according to my calculations and comparative researches, the lines of Ch. Fievez (4612·5, 4564·5) of Young (5570, 5450), of Tacchini (4943 and 5031), and, what is very important, two lines very near the Mg lines *b* and b_2 at 5183·3 and 5172·3 belong to helium, but the line 7055 very probably to coronium. Finally, the lines observed by Capt. Abney and Dr. Schuster in Egypt, May 17th, 1882, *i.e.*, the lines of the spectrum of the corona 4501, 4473, 4401, 4224·4, 4212, 4195, 4179, 4085, and 4067, as well as one at least of the four red lines seen at the same time by Tacchini, 6489, 6492, 6494, 6498, of the corona belong to the II.nd "compound hydrogen spectrum."

The lines seen by the last-named spectroscopists and astronomers in the corona must probably, therefore, as already shown, belong to a relatively cooler portion of the corona very remote from the photosphere. In this region the elements of hydrogen, which were separate in the hotter districts, re-unite partly to form ordinary hydrogen, and partly to the modified ammonioid hydrogen, which emits the II.nd H-spectrum.

PS.— Whilst the above matter is in the press, a new and remarkable confirmation of the wave lengths of the spectrum of water, as foretold by me on May 9th of this year ($\lambda = 2331{\cdot}1$ to $\lambda = 2437{\cdot}2$), has been supplied by Prof. G. D. Liveing.

ON THE EFFECTS PRODUCED BY SMALL QUANTITIES OF BISMUTH ON THE DUCTILITY OF SILVER.

By Surgeon-Major J. SCULLY, Assay Master, Calcutta.

(Continued from p. 226).

II. As it seemed likely that a large number of experiments would be required to determine accurately the smallest amount of bismuth that would injure the ductility of our coinage alloy, and the still smaller proportion that would not sensibly affect this ductility, it was determined to begin the enquiry by a number of laboratory experiments on small bars of silver, before trying the effects of bismuth on ordinary coinage bars and with the procedure for lamination carried out in the Mint. These laboratory

experiments were made in the following way:—Pure silver prepared for assay check purposes, or an alloy of silver and copper of which the exact composition had been determined by assay, was melted in a clean plumbago crucible under charcoal. When the metal was in fusion the necessary amount of bismuth was rolled in a piece of paper, carried down at once to the bottom of the silver bath, and then thoroughly mixed with the silver by stirring. The calculated composition was confirmed by assay of the silver. When this mixture had been accomplished, the contents of the crucible were poured into an open iron ingot mould, and after cooling—either quickly by plunging the casting into water or slowly in contact with the mould—the bar so cast was tested for brittleness by hammering and rolling. The bars cast were of two sizes, one set being 3·75 inches long, 1·125 broad, 0·375 thick, and weighing about 6·2 troy ounces; and another set 2·69 inches long, 1·125 broad, 0·25 thick, and weighing about 4·1 troy ounces. When reduced to the fullest extent by rolling, these bars were converted into straps about 0·015 inch in thickness. In laminating them they were twice annealed, first after having undergone four pinches in the rollers, and again after the tenth pinch from the beginning. Similarly shaped bars of silver, without bismuth, were occasionally laminated in the same way to obtain a sure means of comparison. Before any result was accepted as to brittleness or its absence, the bar under experiment was always re-melted and tried at least a second time. The number of experiments in this series amounted to *fifty-three*, and the following is a summary of the results obtained:—

Fine silver when alloyed with only 1 per mille (one-thousandth part of its weight) of bismuth, and the casting rapidly cooled by plunging it into water as soon as it has set, has its ductility, as tested by lamination, sensibly but slightly impaired, the straps resulting from rolling having slightly jagged edges. When the proportion of bismuth is increased to 2, 3, 4, and 5 per mille, the plan of cooling remaining the same, the raggedness of the edges of the straps was somewhat increased, but not very markedly. If, however, the casting was allowed to cool down completely, but very slowly, in contact either with the mould or a stone floor, the results were very different. Under this condition of cooling, a bar composed of fine silver with 4 per mille of bismuth was completely brittle; it was readily broken, and its fracture was strongly crystalline. On laminating it small cracks appeared all over the surface on the second pinch, the bar emitting a crackling sound under the rolls, much like the "cry" of tin, and on the fourth pinch the bar cracked deeply at the edges. This remarkable effect on the molecular structure of this alloy of silver and bismuth, as due solely to the mode of cooling the casting, was repeatedly verified on the same metal by re-melting and cooling rapidly and slowly alternately. The case seems analogous to that of bronze, where slow cooling of the alloy after casting is said to make it hard and brittle.

Fine silver with 6 per mille of bismuth, rapidly cooled, was distinctly cold-short and crystalline on fracture; the bar cracked on the surface at the fourth pinch. With 7 per mille of bismuth these evidences of diminished ductility were slightly more pronounced. With 8 per mille of bismuth the silver was still more brittle, the bar broke readily when hammered, and cracked all over the surface on the fourth pinch from the rolls. With 9, 10, and 11 per mille of bismuth, the bar of silver could be readily broken in two by merely striking it against the edge of an anvil, the fracture was coarsely crystalline, and the bar, in one case, proved to be very red-short, a mere tap from the tongs sufficing to break it in two when heated for the purpose of annealing. Although these bars were so very brittle, it was still possible to roll them into thin straps after careful annealing; but the edges of the straps so produced were deeply jagged and indented by cracks. These bars also all emitted the peculiar crackling noise under the rolls which has before been mentioned.

An alloy containing 990 parts of silver and 10 of copper then had added to it successively 1, 2, 3, 4, and 5 per mille of bismuth, the castings being rapidly cooled. The remarks already made with reference to fine silver alloyed with the same proportions of bismuth would apply here almost exactly,—that is to say, the bars were rolled out to a thickness of 0·015 with somewhat ragged edges, so that although ductility, as thus tested, was impaired, it was only slightly so. With 6 per mille of bismuth (fineness of metal on assay 983·9) the edges cracked a little, and, after annealing and rolling out, the strap had decidedly jagged edges and was split for some distance at one end. The bars containing 4, 5, and 6 per mille of bismuth were now re-melted and allowed to cool slowly and completely in the mould. They were all found to be highly brittle, broke easily under the hammer,—the fracture being granular and not crystalline,—and on being rolled they cracked badly, all over the surface and at the edges, on the first or second pinch; in one case the bar broke in two on the second pinch. That these very different results were again solely due to the manner of cooling was proved by re-melting and rapidly cooling the castings, when the same metal proved comparatively ductile, as first stated.

Silver of the Indian standard of 916·6 per mille (the rest being copper) to which 2 per mille of bismuth was added, gave on lamination straps with slightly jagged edges and proved to be red-short. With 4 per mille of bismuth the bars showed a few surface cracks on being rolled, and the resulting straps had decidedly jagged edges. Slow cooling of these castings did not affect their ductility, thus showing a marked contrast to what had been observed in the case of fine silver and the alloy containing only 10 per mille of copper. When the amount of bismuth was increased to 5 per mille, the copper present remaining at 83·4 per mille, the bars were decidedly brittle and cracked readily on hammering,—the fracture being again granular, and not crystalline as in the case of fine silver. On lamination both surface and edge cracks developed after four pinches from the rolls, and in annealing one of these bars the whole surface blistered considerably, no doubt owing to the temperature having been carried a little too high. Standard silver with 10 per mille of bismuth, reducing the fineness as ascertained by assay to 906·6, was very brittle, the bars breaking easily under the hammer, and on the fourth pinch from the rolls splitting and cracking all over the surface. In the course of these latter experiments it was ascertained that, with from 83·5 to 70 per mille of copper present, slow or rapid cooling of silver alloys containing bismuth made no appreciable difference in their ductility.

The foregoing experiments having furnished some information as to the amount of bismuth that might be expected to injure our coinage alloy, it was now decided to test that point practically, by operating on coinage bars subjected to the regular procedure for the manufacture of rupees in the Calcutta Mint. The experiments made in this connection were *fourteen* in number. The bars used here for coinage weigh about 253 troy ounces, and are about 20 inches long, 2·25 broad, and 1 inch thick; they are cast in vertical iron moulds. In lamination they are first reduced by eleven pinches to a thickness of 0·23 in.; they are then annealed, and finally reduced by twelve additional pinches to a thickness of 0·06 inch. A number of bars, poured from a pot of which the contents had proved on assay of a granulated sample to be 916·6 fine, were selected for the experiments, and as a preliminary step one of the bars was laminated to test its ductility. It rolled out with smooth "wire" edges, and indeed its ductility was beyond suspicion, as it resulted from a melting of good coins. Another bar of the same batch was now melted and 1 per mille of bismuth added to it, the result of the addition being checked, in this and all following cases, by the assay of a granulated sample of the metal, taken after thorough stirring. At the eighth pinch both edges of the lower half of this bar began to

crack, and at the eleventh pinch these cracks extended towards the middle line of the strap for about a quarter of an inch, and occurred at about every half inch of the edge. After annealing, and in the subsequent lamination to a thickness of 0·065 inch, these cracks increased considerably in number, but did not become sensibly deeper. The strap as finished was pronounced unfit for coinage purposes; for although two blanks could have been cut from its width, the edges were too jagged to admit of the blanks being obtained exactly along the line from which it was desired to cut them,—this position being attained by means of a fixed lateral guide against which the edge of the strap had to be maintained in cutting. With 2 per mille of bismuth the results obtained on rolling were not much worse than with 1 per mille. But the side cracks opened out more, and here again it was noticed that the lower portion of the bar (upper and lower here having reference to the casting in upright moulds) was somewhat less ductile than the upper part.

With 3 per mille of bismuth (fineness on assay 913·8) the bar began to crack on both edges at the ninth pinch; at the eleventh pinch there were many cracks quite a quarter of an inch deep, and after annealing the bar these cracks increased at every pinch, so that at the twenty-first pinch the strap was cracked all along both edges very badly. It would only have been possible to obtain one blank from the width of this strap.

As it was perfectly clear that no further experiments were required with larger proportions of bismuth, the subsequent trials were made on coinage bars containing 0·5 per mille, 0·25 per mille, and, by dilution of the latter bars with standard silver, to even half and a quarter of the lesser proportion just stated. Here the results were rather discordant; they appear to have been somewhat influenced by the state of different rolls, and by quick or slow annealing. The general outcome of the tests, however, was that although some of the straps containing the proportions given of bismuth were jagged at the edges, and so would have yielded a diminished percentage in outturn of good blanks, others were not materially worse than the average of straps without any bismuth at all. As a result of this part of the enquiry, it may, I think, be fairly concluded that if our coinage bars contain less than 0·5 per mille of bismuth their ductility will not be materially affected. It must be borne in mind that these results only apply to bars of the size and shape of those experimented on, and with the particular treatment in lamination above detailed. With thinner bars and a different method of rolling, different results may be expected. The system of cutting out blanks has also to be considered, for in some mints straps with saw edges are not so prejudicial as in others.

(To be continued).

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES,

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 227).

C. CHANCEL (*Compt. Rend.*, li., 882) treated the iron ore with HNO_3, precipitated any H_2SO_4 with $BaCl_2$, and HCl with $AgNO_3$; precipitated the Ag and reduced the iron with H_2S, boiled off in current of CO_2, and precipitated P_2O_5 with nitrate of bismuth. The precipitate contained 31·28 per cent P_2O_5.

R. Warington, jun. (*Jour. Chem. Soc.*, xvi., 304) recommended the use of citric acid instead of tartaric acid, to avoid the precipitation of Mg salts with the—

$Mg_2(NH_4)_2P_2O_8$.

Fr. Mohr (*Zeit. Ann. Chem.*, ii., 250) showed that the precipitate in a solution of iron by sodic phosphate had the formula $Fe_2O_3P_2O_5$. On long washing the precipitate was decomposed, P_2O_5 and Fe_2O_3 dissolving with an acid reactive.

Schloessing (*Compt. Rend.*, lix., 384) ignited the phosphate in a mixture of SiO_2, then transferred to a carbon boat, and heated in a porcelain tube in a current of CO. The loss of weight was P_2O_5. If the porcelain tube is connected with a silver tube heated to redness and containing Cu, the Cu takes up all the P from its volatile compound; or if the gas from the porcelain tube is led into a bulb apparatus containing $AgNO_3$ and warmed in a water-bath to 80° or 90° C., the silver phosphide collected here and the red phosphorus remaining in the tube may be oxidised with HNO_3, evaporated to dryness, heated to incipient fusion, extracted with water, and the residue weighed as $3Ag_2OP_2O_5$.

R. Warington, jun. (CHEM. NEWS, xi.) recommended neutralising the nitric acid solution after separation of SiO_2 with NH_4HO, and precipitating with acetate of lead (or with $Pb(NO_3)_2$ and PbO). The lead phosphate, after washing with warm water containing some ammonic acetate, was dissolved in dilute HNO_3 and decomposed with H_2S. From the filtrate, which contained all the P_2O_5 with very little iron, the P_2O_5 was precipitated after the addition of a little citric acid by Mg mixture.

R. Fresenius (*Zeit. Anal. Chem.*, iii., 446) remarked, in regard to the molybdate method: 1. HNO_3, even in large excess, did not influence the exactness of the method. 2. HCl in large amount prevented, partially or entirely, the precipitation of the phospho-molybdate; 3·3 per cent of HCl gave results that were approximate, but still too low. 3. In the presence of much HNO_3, HCl was still more disadvantageous. 4. H_2SO_4, Fe_2Cl_6, Al_2Cl_6, even in large amount, did not influence the result. 5. With much NH_4Cl the results were too low, as they were also when the solution was very dilute.

F. Knapp (*Zeit. Anal. Chem.*, 1865, 473) and R. Pribram (*Vierteljahrschr. Pr. Pharm.*, xv., 184) claimed that in a solution containing much Al_2O_3 the precipitation of the $Mg_2(NH_4)_2P_2O_8$ in the presence of tartaric acid and ammonia was entirely prevented.

J. Spiller (*Jour. Chem. Soc.* (2), iv., 148) treated the HCl solution with ammonic bisulphide, drove off the excess of SO_2 by heating, cooled the solution to 20° C., and added a solution of ammonic carbonate until the precipitate, at first red, became greenish in colour. This precipitate, which contained all the P_2O_5, was filtered off and dissolved in HCl, the iron separated according to Fresenius's method by $(NH_4)_2S$ and NH_4HO, and the P_2O_5 precipitated in the filtrate by Mg mixture.

Brassier (*Ann. Chem. Phys.* [4], vii., 355) suggested the use of $MgCl_2$ instead of $MgSO_4$.

E. G. Tosh (CHEM. NEWS, xvi., 168) recommended Spiller's method, but instead of separating the Fe_2O_3 and P_2O_5 by $(NH_4)_2S$ and NH_4HO, added citric acid to the HCl acid solution to the precipitate by ammonic carbonate, and precipitated the P_2O_5 by Mg mixture and ammonia, as $Mg_2(NH_4)_2P_2O_8$.

Tantin (CHEM. NEWS, xviii., 252) proposed treating iron or steel with HCl in a flask, and passing the gases evolved through a solution of KHO to separate S, and then through a solution of nitrate of silver in which the phosphuretted hydrogen precipitates silver as phosphide. This phosphide of silver he filtered off and treated with aqua regia, which oxidised the P to P_2O_5 and rendered the Ag insoluble as chloride. The AgCl he filtered off, and determined the P_2O_5 in the filtrate.

W. Kübel (*Zeit. Anal. Chem.*, viii., 125) showed that $Mg_2(NH_4)_2P_2O_8$ was much less soluble in ammonia water than Fresenius supposed. As he found basic magnesic sulphate in this precipitate, he recommended re-solution and re-precipitation.

E. Kessel (*Zeit. Anal. Chem.*, viii., 164) stated that the amount of basic magnesic sulphate precipitated with the

* From "Mining Industries of the United States."

$Mg_2(NH_4)_2P_2O_8$ was very small if no great excess of $MgSO_4$ was used and sufficient NH_4Cl. He also claimed that the presence of soluble Mg salts decreased the solubility of the $Mg_2(NH_4)_2P_2O_8$, and that dilute ammonia dissolved it, the solvent action of this latter being increased by the presence of NH_4Cl.

Th. Petersen (*Verhandl. Geolog. Reichsanst.*, 1869, 80) re-stated the necessity for completely removing SiO_2 before precipitating P_2O_5 by molybdate solution.

F. Kessler (*Jour. Pr. Chem.* [2], 2, 364) proposed to determine P in iron and steel by precipitating the Fe from solution by K_4FeCy_6, and in the filtrate determining P_2O_5 as $Mg(NH_4)_2P_2O_8$.

Meinicker (*Zeit. Anal. Chem.*, 1871, p. 280) suggested dissolving iron or steel in double chloride of copper and ammonium, filtering, and treating the residue with HNO_3, and precipitating P_2O_5 in this solution with molybdate solution.

E. Richters (*Zeit. Anal. Chem.*, 1871, 305) recommended washing the precipitate of ammonic phospho-molybdate with solution of ammonic nitrate.

E. W. Parnell (CHEM. NEWS, xxiii., 145) showed the insolubility of $Mg_2(NH_4)_2P_2O_8$ in ammoniacal liquids containing excess of Mg salt or sodic phosphate.

J. Parry (CHEM. NEWS, xxv., 229) dissolved iron or steel in aqua regia, and after separating SiO_2 transferred the HCl solution to a flask and added sufficient ammonia to precipitate all the Fe_2O_3, then just enough HNO_3 to dissolve the precipitate. He heated the solution nearly to boiling, and added an excess of an aqueous solution of ammonic molybdate. If there was no precipitate he added HNO_3, drop by drop, shaking the flask constantly until a distinct precipitate appeared, after which he added a small additional amount of HNO_3, shook the flask well, and allowed the precipitate to settle for a few minutes. He filtered, washed with water containing a little HNO_3, and weighed the precipitate of phospho-molybdate of ammonia, which contained 1·63 per cent of P.

T. R. Ogilvie (CHEM. NEWS, xxxi., 274; xxxii., 5, 12, 70) made a number of experiments to show the effect of varying amounts of Mg salts, citric acid, Al_2O_3, Fe_2O_3, and ammonic oxalate on the precipitation of P_2O_5 as $Mg_2(NH_4)_2P_2O_8$.

E. W. Parnell (CHEM. NEWS, xxxii., 222) said, in answer to Ogilvie, that the purity of the precipitate of $Mg_2(NH_4)_2P_2O_8$ was not affected by the quantity of the Mg salts, but by the manner of precipitation. He recommended the use of dilute solutions, and said they should stand quiet for a long time.

W. Flight (*Jour. Chem. Soc.*, xxviii., 592) discussed various methods and recommended:—

1. To separate P_2O_5 from Fe_2O_3, he passed H_2S through the weak acid solution, then added $(NH_4)_2S$ in excess, boiled, filtered, washed with H_2S water, and determined P_2O_5 in filtrate.

2. From Al_2O_3 he added excess of NaHO to solution then $BaCl_2$ to precipitate all the P_2O_5, allowed to stand several hours protected from CO_2, filtered and washed with NaHO water, decomposed precipitate and determined P_2O_5.

3. From Fe_2O_3 and Al_2O_3 he treated the not too acid solution with excess of $Na_2S_2O_3$, boiled, filtered P_2O_5 partly with Al_2O_3 in precipitate and partly with FeO in filtrate. He then separated P_2O_5 by methods I and II.

T. E. Cairns (*Am. Chemist.*, vii., 215) showed the inaccuracy of Sonnenschein's molybdate method when the solution was not heated above 40° C., unless it was allowed to stand several days. He recommended dissolving the iron or steel in HCl and $KClO_3$, evaporating to dryness to get rid of SiO_2, precipitating the Fe_2O_3 and P_2O_5 by NH_4HO, filtering, dissolving this precipitate in HNO_3, and evaporating down, diluting to 250 c.c., neutralising by NH_4HO, adding "molybdate solution," heating nearly to boiling and allowing the phospho-molybdate to settle. He recommended washing this precipitate with "molybdic acid solution," dissolving in NH_4HO, neutralising by HCl, and precipitating the P_2O_5 by Mg mixture.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, November 17th, 1887.

Mr. WILLIAM CROOKES, F.R.S., President, in the Chair

MESSRS. EDWIN J. BALL and David Lloyd Howard were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Peter Coulson Burn, Jun., King's Lynn, Norfolk; F. Barker Cooke, 40, Wilson Road, Camberwell, S.E.; Agnew Griffith, Daisy Mount, Blundell Sands, Liverpool; Frank Edward Lease, Caledonia Estate, Province Willesley, Straits Settlements; Edmund George McBretney, 25, Denton Terrace, Castleford, Yorks.; W. Sedgwick Saunders, M.D., 13, Queen Street, Cheapside, E.C.

The following papers were read:—

81. "*Zinc-copper and Tin-copper Alloys.*" By A. P. LAURIE.

The author finds that if the zinc plate of a Daniell cell be replaced by a compound plate formed by joining copper and zinc, the cell has the same electromotive force as one in which zinc alone is used; this is true, even though the zinc surface be only 1-1000th part of the copper surface. If the zinc plate be replaced by copper-zinc alloys, no deflection of the electrometer is observed as long as the alloy contains less than 67 per cent of zinc; at this point, however, a big deflection, practically equivalent to that given by zinc, is suddenly obtained. This result, in the author's opinion, may be taken as evidence of the existence of a compound of the two metals of the formula $CuZn_2$. Alloys containing a greater proportion of zinc behave like zinc alone. Similarly in the case of tin-copper alloys, a sudden rise of electromotive force is observed when the proportion of tin in the alloy exceeds that which would be contained in a compound of the formula Cu_3Sn. This result is in harmony with the evidence already obtained by observations of the density and thermal and electrical conductivity of the copper-tin alloys. If an alloy containing a larger percentage of tin than Cu_3Sn, in a state of fine division, be placed in a copper cup and used in place of the zinc in a cuprous chloride cell, the excess of tin is gradually eaten out, leaving approximately the alloy Cu_3Sn; this alloy undergoes no change if the circuit be kept closed.

DISCUSSION.

Dr. WRIGHT, after asking whether the author had made any experiments with ternary alloys, referred to observations which he had had occasion to make on lead-zinc-tin alloys. It is well known that lead and zinc will not permanently mix, but that on cooling the lead separates with a little zinc and the zinc with a little lead: he had found that tin behaved itself indifferently to the two metals, dividing itself between them; but the zinc appeared to be able to take up more lead, and the lead more zinc, in presence of the tin.

Mr. BALL said that under Professor Robert Austen's direction he had made experiments on the effect of melting lead—a metal which does not alloy with copper—with copper-tin alloys; it was found, however, that the lead had no influence, the copper-tin alloy separating out unmixed.

Professor RAMSAY suggested the application of the author's method to lead-tin alloys, which appeared to be but "solidified solutions."

The President drew attention to the fact that amalgams presented many peculiarities. Thus iron, antimony, sodium, silver, and gold will dissolve in mercury: but if antimony amalgam be mixed with sodium amalgam the antimony is thrown out—iron also.

82. "*The Halogen Substituted Derivatives of Benzalmalonic Acid.*" By C. M. Stuart, M.A.

The author describes the preparation of orthochlorobenzaldehyde, orthobromobenzaldehyde, and orthiodobenzaldehyde, and their transformation into the corresponding halogen substituted benzalmalonic acids; and the decompositions which these acids and *o*-methoxybenzalmalonic acid undergo when boiled with water: on the one hand (Eq. I.), into benzaldehyde and malonic acid; and, on the other (Eq. II.), into carbon dioxide and cinnamic acid (see accompanying table; comp. *Trans.*, 1886, 357). On reduction, orthonitrobenzalmalonic acid yields the carbostyrilcarboxylic acid described by Friedlander and Göhring.

	Boiled for one hour. Decomposition according to			Boiled for fifteen minutes. Decomposition according to		
	Eq. I.	Eq. II.	Total.	Eq. I.	Eq. II.	Total.
Benzalmalonic acid	85·8	10·8	96·6	57·8	1·41	59·2
	84·4	10·6	95·0	58·3	1·25	59·5
Orthonitrobenzalmalonic acid	24·5	5·7	30·2	8·70	1·18	9·88
	23·6	6·5	30·1	8·71	1·25	9·96
	24·4	6·4	30·8	—	—	—
Orthochlorobenzalmalonic acid	65·17	8·40	73·57	30·8	3·36	34·16
	64·35	9·64	73·99	30·8	3·47	34·27
Orthobromobenzalmalonic acid	66·0	10·6	76·6	33·0	3·22	36·22
	67·6	10·2	77·8	32·3	2·84	35·14
Orthiodobenzalmalonic acid	67·6	9·09	76·69	33·0	3·5	36·5
	65·7	10·09	75·79	31·9	3·0	34·9
Orthomethoxybenzalmalonic acid	78·1	8·16	86·2	45·9	2·72	48·62
	76·4	9·27	85·6	44·0	2·04	46·04

83. "*Note on a Modification of Traube's Capillarimeter.*" By H. S. Elworthy.

The author describes a modification of Traube's instrument for determining fusel oil in spirit by measuring the capillary depression, the essential feature being that the tube is fixed at an angle approaching the horizontal instead of vertical. In Traube's instrument a pure 20 per cent (by volume) spirit is said to rise 50 m.m.; but in the author's modification the rise is 173 m.m., and 1 per cent of fusel oil produces a depression of 25 m.m. instead of only 7 m.m.

84. "*The Formation of Hyponitrites: a Reply.*" By Edward Divers, M.D., F.R.S.

The paper on the "Formation of Hyponitrites," by Professor Dunstan and Mr. Dymond (*Trans.*, 1887, 646), which I received a few days ago, contains some references to papers by Mr. Haga and myself, and by me alone, which are erroneous, and place us in a false position.

(1). In the section headed "Discussion of Results," p. 656, the authors say:—"We are unable to confirm the statement made by Divers and Haga that ferrous hydroxide in presence of alkali does not form hyponitrite from nitric oxide?" Such a statement has not been made by us. All that we have said on this subject occurs in two lines near the end of a short paper describing the formation of hyponitrite from nitric oxide by acting on it with potassium stannite, in reference to the only experiment we have made with ferrous hydroxide and nitric oxide, one in which we employed strong solution of potassium hydroxide with the ferrous hydroxide. Our words were (*Trans.*, 1885, 364): "Neither hydroxylamine nor hyponitrite could be detected as products of this reaction." The authors record their repetition of this experiment, with results the same as ours (p. 649), and have thus actually confirmed our only statement in the matter. The authors signally confirm, also, our other experience with ferrous hydroxide, in failing, like us, *by Zorn's process*, to reduce nitrites and nitrates to hyponitrites.

(2). The authors find that I regard "the formation of hyponitrites as due to the direct *withdrawal* of oxygen from the nitrite or nitrate by the metal" (p. 657), and give as references my first paper on "Hyponitrites" (*Proc. Roy. Soc.*, 1871), and subsequent communications, more particularly that "On the Production of Hydroxylamine from Nitric Acid," presented to this Society. For the very sufficient reason, however, that I have as yet formed no clear notion of the constitution of hyponitrites, I have never offered any formal theory of their formation, unless it be the very one offered by the authors themselves, incidentally given in my discussion of the reduction of nitric acid by metals (see below). Nowhere otherwise in that paper, nor at all in any other communication, have I treated of the theory of the formation of hyponitrites, so far as I can find. In my first paper occurs only the equation $NO_2Na + 2Na = NONa + Na_2O$, and the bare statement that the sodium reduces the nitrite. The authors were, therefore, hardly in the position to state that I regard its formation as due to the direct withdrawal of oxygen, the word withdrawal italicised, in order plainly to make a contrast to their supposition that first sodium nitrite directly combines with hydrogen. I have long ago expressed the latter view myself, but I should still express *the result* of the reaction by the above equation in my first paper.

(3). The authors further find me to suggest "that a compound of the formula $NaNONa_2$ is formed by the *substitution*" (the italics again are theirs), "of two atoms of sodium for one of oxygen in the nitrite—

$$NaNO_2 + 4Na = NaNONa_2 + Na_2O"$$

(p. 657). But at the place referred to (*Trans.*, 1883, 458) there is only the equation—

$$Zn(NO)_2 + 4Zn = Zn_2N_2O_2Zn + 2ZnO,$$

together with words which have rightly led the authors to write 2Na for Zn, and halve the formula. Of the substitution of metal for oxygen there is neither word nor implication in my paper. $Zn_2N_2O_2Zn$, or Na_2NONa, is clearly hydroxylamine with zinc or sodium in place of hydrogen, but the authors have, by some strange error, written, three times over, as my formula, $NaNONa_2$. Such an unjustifiable mode of writing, it may serve to illustrate the absurd view they attribute to me, that two atoms of sodium are substituted for one of the atoms of the oxygen of the nitrite (I), but no such view is expressed or countenanced in any paper of mine. The authors will, I am sure, agree with me that a position-formula, which contains two or more groups of atoms of the same element, does not preserve its meaning when re-written with another arrangement of its symbols.

(4). Having shown the insufficiency of the views they attribute to me, incorrectly as I have just pointed out, the authors proceed to advance a view of their own, which is

nevertheless to be found stated explicitly in that communication of mine to the Society, to which they principally refer. They say:—"The hypothesis we wish to suggest as at once the simplest and most in accordance with the facts, supposes that the sodium nitrite first directly combines with two atoms of hydrogen. The formula of the new compound will be Na·N : $(OH)_2$, or perhaps NaONH·OH. This substance will, on the one hand, split up into sodium hyponitrite and water—

$$2NaN(OH)_2 = Na_2N_2O_2 + 2H_2O,$$

and on the other be acted on by hydrogen, yielding hydroxylamine and sodium hydroxide,—

$$NaN(OH)_2 + H_2 = NH_2OH + NaOH.$$

More hydrogen will yield ammonia . . ." (p. 657). Essentially all that is contained in the above extract is given by me in my paper on the "Production of Hydroxylamine from Nitric Acid" (xliii., 443). I there suggest that nitrous acid "passes next to a transition-body capable of decomposing to hyponitrous acid, but readily passing on directly to hydroxylamine, thus:—

$$HNO_2 + H_2 = HN(OH)_2 = HNO + OH_2,$$

or otherwise,

$$HN(OH)_2 + 2H = H_2NOH + OH_2,$$

a repetition of which action would give ammonia" (*op. cit.*, p. 462).

I have much less confidence than the authors appear to have, as to the sufficiency of this view, which was indeed only expressed by me incidentally in connection with the reduction of nitric acid, and I should not have felt induced to assert my claim to it now, had the authors confined themselves to putting it forward as new, and not, with many references to my papers, erred in representing me as having advanced only other and extravagant views.

85. "*Reply to the Foregoing Note.*" By W. R. DUNSTAN.

1. As regards the interaction of nitric oxide and ferrous hydroxide, the statement quoted by Dr. Divers in par. 1 is only a fair interpretation of his own words. If Dr. Divers believed that hyponitrite was formed, but could not be detected in presence of the excess of alkali (which we have shown to be the case), misunderstanding would have been avoided had he explicitly said so, although there would have been, at that time, an absence of experimental evidence for the suggestion. This reference to Zorn's process does not correctly represent our conclusion. We found, contrary to the experience of Divers and Haga, that hyponitrite can be formed from nitrite by a process which is substantially that proposed by Zorn.

2. We certainly had gathered from Dr. Divers's papers that he regarded the formation of hyponitrite from nitrite as the result of the direct withdrawal of oxygen by sodium, and not of the intervention of hydrogen. The habitual exclusion of water from his equations is in itself a sufficient justification for our statement. I fail to find in any of Dr. Divers's papers an expression of the view that, in the formation of sodium hyponitrite by the action of sodium on sodium nitrite, water is the necessary link in the series of interacting compounds, and that the hydrogen of this water first attaches itself to sodium nitrite.

3. The "absurd view" that we had attributed to Dr. Divers has arisen from a misunderstanding of his formula Na_2NONa, or, as we had written it, $NaNONa_2$. The equation he gives certainly involves the substitution of sodium for oxygen, but Dr. Divers now explains that the resulting compound is to be regarded, not as a sodium derivative of sodium nitrite, but as a metallic derivative of hydroxylamine.

4. I am surprised to find that Dr. Divers claims as his own the hypothesis we have suggested to account for the formation of hyponitrite and hydroxylamine from nitrites and nitric oxide. He admits that he has never fully discussed the general question. He has proposed a similar theory to account for certain decompositions of nitric acid by the tin zinc metals, but he nowhere attempts to show that an analogous change takes place when sodium acts on dissolved sodium nitrite. Moreover, there is no recorded evidence that Dr. Divers had noticed the significance of the *simultaneous* formation of hyponitrite and hydroxylamine from sodium and sodium nitrite, and he certainly had not shown that the hydroxylamine was not derived from the hyponitrite; on the contrary, he has suggested that hyponitrite does yield hydroxylamine when hydrogenised (*Trans.*, 1885, 204). It may fairly be said that Dr. Divers was not even in possession of the facts which our hypothesis was devised to explain. My only object in writing this rejoinder is to point out the grounds for attributing to Dr. Divers the views to which he now takes exception. I am glad to find that after all our interpretations of the facts do not appear to be so divergent as I had formerly supposed.

PHYSICAL SOCIETY.

November 26th, 1887.

Dr. BALFOUR STEWART, President, in the Chair.

MR. ASUTOSH MACHOPADHYAY, M.A., F.R.S., was elected a member of the Society.

The following communications were read:—

"*On the Analogies of Influence Machines and Dynamos.*" By Prof. S. P. THOMPSON, D.Sc.

The author pointed out that in nearly all influence machines there are two stationary parts ("inductors") electrified oppositely which are analogous to the field magnets of dynamos, and a revolving part carrying "*sectors*" which correspond to the "*sections*" of an armature. To prevent ambiguity Prof. Thompson proposes to call the inductors "*field plates*" and the revolving parts as a whole an "*armature*."

In the Winshurst machine both field plates and armature rotate, and each act as field plates and armature alternately.

In the two field-plate influence machines there are four, and sometimes six, brushes. Two of these act as potential equalisers, two as field-plate exciters, and the remaining two (if any) are generally placed in the "discharge" or external circuit.

The Holtz machine having only four brushes, two serve the double purpose of potential equalisers and discharge circuit, and this machine excites itself best when the discharging rods are in contact. In this respect it resembles a series dynamo, which only excites itself when the external circuit is closed, but on opening the circuit (say by inserting an arc lamp) produces remarkable effects. So in the Holtz machine, on separating the discharging knobs a shower of sparks result.

The Toepler machine (made by Voss), having six brushes, resembles a shunt dynamo, and excites itself best on open external circuit.

Analogues were traced between Thomson's replenisher and the Griscom motor.

Armatures of influence machines, as in dynamos, can be divided into ring, drum, disc, and pole armatures, and examples of each kind were mentioned. The "Clark gas-lighter" is a good example of a drum armature, and a diagram showing the internal arrangements was exhibited.

An example of an analogue to the compound dynamo was mentioned as existing at Cambridge in the form of a Holtz machine believed to have been modified by Clerk Maxwell.

Another analogy with dynamos is found in the displacement of the electric field when the armature is rotated, just as the magnetic field of a dynamo is shifted round in the direction of rotation.

Further analogies were traced between "critical velocity" of dynamos (which depends on the resistance in the circuit) below which they do not excite themselves,

and a similar critical velocity of influence machines; *e.g.*, in a Wimshurst or Voss machine the potential equalising circuit should have a low resistance if they are to excite themselves readily.

Self-exciting dynamos excite better when the iron is bad and retains its magnetism, and influence machines excite better when the field plates are made of paper or such substance as can well retain a residual charge.

Finally, an apparatus analogous to Thomson's water-dropping accumulator was exhibited, in which an electric current was generated by mercury falling down a tube between the poles of a magnet.

Prof. AYRTON pointed out an historical analogy between the inventions of the influence machine and the dynamo; for as Varley anticipated Thomson in the invention of the self-exciting influence machine, so Hjorth anticipated Varley, Wheatstone, and Siemens in the invention of the self-exciting dynamo.

Dr. FLEMING considered that, just as all influence machines may be looked upon as descendants of Volta's "electrophorus," so dynamos are those of Faraday's "coil and magnet."

"*On the Effect produced on the Thermo-electric Properties of Iron, when under Stress or Strain, by raising the Temperature to a Bright Red Heat.*" By Mr. HERBERT TOMLINSON, B.A.

In June last the author described some remarkable "Effects of Change of Temperature on Twisting and Untwisting Wires which have suffered Permanent Torsion," of which the present paper is a continuation. It is found that at or about the critical temperature (a bright red heat), mentioned in the previous paper, a sudden E.M.F. is generated at the junction of two iron wires, one of which is under stress or has suffered permanent strain, and the other in an unstrained state. By suddenly bringing a red-hot iron wire in contact with cold iron, an E.M.F. of about $\frac{1}{10}$ volt is produced. If copper be used the E.M.F. is about $\frac{1}{8}$ volt.

The author also showed that if one part of an annealed iron wire is heated to a bright red by a Bunsen flame, an E.M.F. is generated if the position of the flame is slightly altered, the direction of the E.M.F. depending on the direction of the displacement.

Prof. AYRTON believed the high E.M.F. exhibited by hot and cold copper was really due to oxide of copper; and Prof. S. P. THOMPSON said that different effects could be produced by using the oxidising or reducing parts of the flame in heating the wire.

"*On a Method of discriminating Real from Accidental Coincidences between the Lines of Different Spectra, with some Applications.*" By E. T. J. LOVE, M.A.

The differences between the measured wave-lengths of the lines to be composed are arranged in groups, each group containing those observations the errors of which lie within certain narrow limits. The number of observations in each group is then plotted as ordinate and the average error of the group as abscissæ, and the resulting curve drawn. The coincidences are deemed real or accidental according as the resulting curve does or does not resemble the curve of errors, $y = a\,\varepsilon^{-c^2x^2}$.

Interesting applications bearing on the presence of cerium in the sun, and on Prof. Grimwald's recent investigations relating to the constitution of so-called "*elements*," are appended.

OBITUARY.

PROFESSOR BLOXAM.

WE regret having to put on record the death of Professor Bloxam, which took place on Monday morning, 29th ult. For about a week previously he had been suffering from an attack of acute bronchitis. As most of our readers know, the deceased was an indefatigable and meritorious worker in chemistry. He formerly contributed to the CHEMICAL NEWS a number of very useful analytical notes. These he called his "holiday tasks," as they were the fruit of researches carried on during the vacations, as he never left London. He held the chair of chemistry at King's College, and was greatly admired as a lecturer. His principal published work was "Chemistry, Inorganic and Organic," an excellent manual.

Prof. Bloxam was interred yesterday, December 1st, at the Charlton Cemetery.

NOTICES OF BOOKS.

Gas-Works Statistics. Edited by C. W. HASTINGS. London: Scientific Publishing Company (Limited).

EITHER gas-works are much more numerous than water-works or their officials are more communicative than the secretaries and managers of water-works. The columns seem much better filled up. No establishment seems this year to have performed the feat of selling a considerable quantity of gas more than it has produced. In Bury the sales slightly exceed the manufacture, but the quantity is so small—362,000 cubic feet—that it may have been in stock at the beginning of the year. Dartford and Normanton have exactly disposed of their entire yield.

The illuminating power of the gas supplied seems to have increased, perhaps from a wholesome dread of the electric light. As far as England is concerned Berwick still leads the list with its thirty-candle gas; twenty-two towns are supplied with gas at twenty-candle power or upwards. At the bottom of the list figure Yarmouth and Baslow with thirteen-candle gas, and Theale with twelve.

Whether from a superior quality of material or from greater skill, Scotch gas-works still keep ahead of those in England in illuminating power. Banchory comes first with its thirty-three-candle gas; twenty-two towns have gas of thirty-candle power or upwards, whilst the lowest returns we find are twenty-four and twenty-five candles respectively.

The Gas and Water Companies' Directory, 1887. Edited by CHARLES W. HASTINGS. London: Scientific Publishing Company.

THIS work will be of manifest utility to the numerous persons who are brought into business relations with the Companies in question. We find arranged in parallel columns, opposite the name of each town or locality, the date of formation of the undertaking; the date of special Act, if any; the total paid up share capital, dividends, total loan capital issued; the names of chairman, engineer or manager, and secretary; the lessee, owner, or corporation; the population, distance from London, and the railway by which the place is accessible.

The populations given are not those of the towns, but of the entire districts supplied by the gas- or water-works, and which often extend far beyond the municipal limits. The reader who does not bear this in mind will stumble upon apparent contradictions. Certain Companies appear to have furnished no returns.

Water-Works Statistics, 1887. Edited by C. W. HASTINGS. London: Scientific Publishing Company (Limited).

WE are pleased to notice in this edition a great improvement as compared with the issues in former years. The very useless column, stating whether the water-supply of a town was brought by pumping or by gravitation, has been suppressed. In its stead we find columns showing the character of the water and the death-rate. We cannot but regret that some towns have omitted to give particulars under these heads. Among these defaulters rank Liverpool, Newcastle and Gateshead, Roch-

dale, Rotherham, Ashton-under-Lyne, Brighton, Bristol, Cambridge, Sheffield, &c. The degrees of hardness given range from 2 to 20. Descriptions of waters given without any analytical data are less satisfactory. Thus one town describes its supply as "very pure and soft," another as "excellent," and a third as "first class purity."

The sources of supply seem now to be stated with more regard to the geological character of the district. Three towns describe their water as softened by the Clarke process, and one by that of Dr. Atkins. A few towns still refrain from giving any statistics whatever. Of course if town clerks, secretaries to companies, &c., neglect to furnish the information, the Editor has no means of compelling them; but we must repeat what we have stated in a former year, that these returns, if they could be rendered complete, would be a most valuable document in relation to public health.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 19, November 7, 1887.

On the State of Potash in Plants, the Soil, and Vegetable Earth, and on its Determination.—MM. Berthelot and André.—The variation in the quantities of potash obtained in aqueous, ammoniacal, acetic, nitric, hydrochloric, &c., extracts of a soil depends on the alteration of the silicates during calcination. They show that the potash of the soil cannot be determined without we eliminate the silica. It is necessary to estimate all the potash of the soil capable of intervening in reactions more or less slow. No precise line of demarcation can be drawn between the potash of the soil which is immediately assimilable and the potash capable—not to go further—of intervening in the course of a year's vegetation. It is not enough to determine the potash extracted on treating the soil either with pure cold water or with cold dilute acid. Not only is this determination imperfect, as the portion rendered soluble varies with the temperature and the other conditions of the experiment, but it is so small a fraction of the total potash that it can teach us nothing of value either on the reserve-stock of potash in the soil or on the complementary proportion of potassic manures.

On a Diterebenthyle.—Adolphe Renard.—The composition of this compound, which is obtained by a tedious process from the volatile oils of resin, is $C_{20}H_{30}$. Its sp. gr. at 18° is 0·9688, its index of refraction is 1·53, and its rotatory power + 59°. Its vapour density is 9·6. In its properties it borders on the carbides of the terebic series. If spread out in a thin layer in contact with air it absorbs, in fifteen days, about one-tenth of its weight of oxygen, and is transformed into a pitchy varnish. Chromic acid in an acetic solution, converts it into carbonic acid and carbon monoxide. Potassium permanganate, in a watery solution, converts it into carbonic, formic, acetic, and propionic acids.

Metallic Derivatives of Acetyl-acetone.— Alphonse Combes. — The author has shown in former memoirs that the hydrogen atoms of the central chain, CH_2, characteristic of acetyl-acetone, present remarkable analogies with the hydrogens of the acid hydroxyls. They are not attacked by the direct action of chlorine, and they can be easily substituted by sodium. He now shows that acetyl-acetone and its homologues act upon metallic salts like true strong acids, and that we may thus obtain with all the metals a new class of definite crystalline compounds, the acetyl-acetonates, answering to the general formula $(C_5H_7O_2)nM$, M being a metal of *n* atomicity.

An Artificial Textile Fibre resembling Silk.—M. de Chardonnet.— The author dissolves 3 grms. of nitro-cellulose in 100 to 150 c.c. of a mixture of equal parts of alcohol and ether. He adds 2·5 c.c. of a filtered solution at one-tenth of the dry ferrous chloride of commerce in alcohol, or of stannous chloride, and further, 1·5 c.c. of a solution of tannic acid in alcohol. The whole is filtered in a closed apparatus to prevent loss by evaporation. The liquid is placed in a vertical reservoir, having at its bottom a blowpipe nozzle of glass or platinum. This pipe forms an acute cone with an orifice of from 0·10 to 0·20 m.m., the thickness of the margin not exceeding 0·1 m.m. This aperture opens into a vessel of water acidulated with ¼ per cent of mono-hydrated nitric acid. The level in the reservoir being some centimetres higher than in the vessel of water, the outflow proceeds easily. The fluid thread hardens at once in the acidulated water, and may be drawn out by a uniform movement. The thread thus formed must be dried rapidly by traversing a current of dry (not hot) air, and may be wound up as soon as dry. It is grey or black, but a number of soluble colouring-matters may be introduced into the ethereal solution, thus obtaining threads of all colours.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., July, 1887.

Tanning by Means of an Alkaline Extract of Coal.—P. F. Reisch.— By digesting coal-dust with caustic soda at a boil and neutralising this liquor with hydrochloric acid, the author obtains a new tanning agent, which he names pyrofuscine. He considers that the new process is more complicated than the usual tanning processes, but that it is 50 per cent cheaper than the bark process, and 20 to 30 per cent cheaper than the alum process.—*Dingler's Polyt. Jonrnal.*

Laboratory Apparatus for Fractional Distillations.—P. Monnet.—This paper cannot be intelligibly reproduced without the accompanying illustration.

Industrial Review and Various Patents.—A collection of specifications mostly relating to colouring-matters.

Exhibition of the Chemical Society of Paris.—M. de N.—This society has again got up an exhibition of chemical products at the Conservatoire des Arts et Metiers. The author, in concluding, says:—"Do not let us forget that chemistry, a science modern and completely French, has now become cosmopolitan."

Use of Glycerin to prevent Wool from being injured by prolonged Exposure to Heat.—J. Persoz.— The author finds that wool, if previously saturated with a 10 per cent solution of glycerin, can bear a prolonged exposure to 130° to 140° without injury.

Journal fur Praktische Chemie.
New Series, Vol. xxxv., Parts 6 and 7.

Researches from the Chemical Laboratory of the University of Leipzig.—These consist of papers by B. Hotte on the action of phenylhydrazine on the anhydrides of bibasic acids, especially phthalic anhydride, and by J. H. Reed on the methyl-derivatives of the naphtho-quinolines and on β-naphtho-acridine.

Studies on the Manufacture of Santonine. — A. Busch.—An account of this manufacture as carried on at Orenburg.

On Solid Hydroxilised Hydrogen Phosphide.—B. Franke.—Solid phosphorus oxide, commonly so-called, is an oxyhydrogen phosphide, of a feebly basic character. The hydrogen in its phosphide can be replaced by powerful alkalies.

Some Constant Apparatus for Generating Gases. Chr. Sleenbuch.—This memoir requires the accompanying diagram.

The Addition of Sodium-acetacetic and Sodium-malonic Ethers to the Ethers of Non-saturated Acids.—A. Michael.—This paper does not admit of useful abstraction.

Reduction of *a* and Allo-*a*-bromo-cinnamic Acids to Cinnamic Acid.—A. Michael.—The solution of the bromo-acid in glacial acetic acid was treated with zinc-powder, when a liberation of hydrogen occurs after the addition of a few drops of a dilute solution of platinum chloride.

On Aromatic Hydroxylamines.—A. Michael and G. M. Browne.—The authors obtain pikrylhydroxylamine by the action of picric ethyl ether upon hydroxylamine.

Analysis of the Mother-Liquor and the Saliferous Water of a Lake situate near the Stolupin Mineral Springs.—P. Bulitsch.—A memoir of merely local interest.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Colour Lakes.—Can any of your readers give me the names of any really good works on the preparation and properties of colour lake?—R. Lloyd.

MEETINGS FOR THE WEEK.

Monday, 5th.—Medical, 8.30.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Arts, 8. "The Elements of Architectural Design." by H. H. Statham.
—— Society of Chemical Industry, 8. "On the New Weldon-Pechiney Process for the Manufacture of Chlorine from Magnesium Chloride," by Professor Dewar, M.A., F.R.S.
Tuesday, 6th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
Wednesday, 7th.—Society of Arts, 8. "The Chemistry, Commerce, and Uses of Eggs of Various Kinds," by P. L. Simmonds.
Thursday, 8th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— Telegraphic Engineers, 8.
Friday, 9th.—Quekett Club, 8.
—— Astronomical, 8.
Saturday, 10th.—Physical, 3. "Optical Properties of Phenyl-thio-carbimide," by H. G. Madan. "Recalescence of Iron," by H. Tomlinson. "On the Rotation of a Copper Sphere and of Copper Wire Helices when freely suspended in a Magnetic Field," by Dr. H. C. Shettle.

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THE CHEMICAL NEWS.

VOL. LVI. No. 1463.

FURTHER CONTRIBUTIONS TO THE METALLURGY OF BISMUTH.*

By EDWARD MATTHEY, F.S.A., F.C.S., Assoc. Roy. Sch. Mines.

§ 3. *Bismuth: its Separation from Copper.*

IN the Paper upon this interesting metal, which I had the honour of bringing under the notice of the Royal Society in February last,† I referred to the difficulties with which the treatment of bismuth is surrounded when associated with other metals, by any very rapid or comprehensive process.

During the conduct of my operations in the reduction of bismuth from its ores, and its subsequent refining, I have frequently found this metal to contain a small proportion of copper, an element most detrimental even in small traces, and hitherto, I believe, only eliminated by a wet process, costly in practice and tedious in operation, it being necessary by such method to dissolve up the whole of the alloy and precipitate the bismuth in the usual manner—a bulky operation, and one requiring a considerable amount of time. It became therefore advisable, in order to treat cupreous bismuth rapidly and upon a commercial scale, to effect this separation, if possible, by means of a dry process.

In this I have succeeded.

Having observed, in conducting experiments with bismuth and its sulphides, that sulphide of bismuth becomes very easily impregnated with copper, I made the simple experiment of fusing the cupreous bismuth with bismuth sulphide, and found it possible by this means to remove every trace of copper, the sulphur readily combining with the metallic copper.

In this absorption a proportion of bismuth is reduced equivalent to the amount of copper taken up in the operation.

The residual bismuth and copper sulphides thus produced amount to but a small proportion in comparison with the quantity of alloy treated, and the bismuth is readily recovered by subsequent reduction and re fusion.

Large quantities of alloy can be treated at one operation, and the bismuth so freed from copper is available for commercial purposes. I have found it better, when bismuth is associated with other metals, such as arsenic, antimony, lead, tellurium, &c., as well as with copper, to separate all these metals (see former papers) before attempting to remove the copper by the foregoing method.

The operation has been conducted successfully upon many thousands of pounds of similar alloy, and the following figures will show the results obtained in one case, as an example:—

Weight of cupreous bismuth treated = 314 lbs., containing 0·10 per cent of copper, equal to approximately 0·3 lbs.

	Pounds.
From the operation described I obtained of bismuth free from copper	282·0
Of bismuth subsequently reduced and refined from the skimmings	29·9
And bismuth left in residues for further treatment with larger quantities (by determination)	2·0
	313·9
Copper from the skimmings	0·2
Copper left in residues	0·1
	0·3

Thus the whole of the copper and of the bismuth, within a small fraction, is accounted for, the latter being obtained as commercially pure bismuth *and wholly free from copper*.

As the above operation shows, the first separation frees 90 per cent of the bismuth *at once* from the copper associated with it.

It may be as well to state that I have effected complete separation with bismuth containing proportions of copper varying from one-tenth of 1 per cent to 1 per cent by the above process.

* A Paper read before the Royal Society, November 23rd 1887.
† CHEMICAL NEWS, vol. lv., p. 71.

ISOMERIC NAPHTHALENE DERIVATIVES.*

VALUABLE contributions to our knowledge of the naphthalene derivatives have been made during the past year by Bamberger, Cléve, Ekstrand, Forsling, Guareschi and Biginelli, and others; my own investigations have also progressed very satisfactorily; and from the results obtained it is more than ever obvious that the information to be derived from the study of naphthalene derivatives will be of considerable importance, as it will unquestionably serve to throw light on the nature of the changes involved in the formation of substitution derivatives generally, and on laws of substitution.

Sulphonation of α-mono-derivatives.—The behaviour of α-chloro- and bromo-naphthalene was referred to in the last report; that of α-iodo-naphthalene has since been found to be precisely similar, as this compound yields the 1 : 4 sulphonic acid as main product, together with an isomer. The latter, however, has not yet been obtained in sufficient quantity to satisfactorily determine its specific characters. The 1 : 4 sulpho-chloride crystallises in massive prisms, melting at 123°; bromine at once displaces the sulpho-group in the acid, forming 1 : 4 iodo-bromo-naphthalene (m.p. 88°).

α-Cyano-naphthalene yields an acid which forms well-characterised salts, &c.: this is undoubtedly an α-sulphonic derivative, as it is converted by fusion with potash into an *hydroxycarboxylic* acid, from which α-naphthol may be obtained by removal of carbon dioxide. The hydroxy-acid appears not to be identical with the α-hydroxy-acid prepared from α-naphtoic acid; if this be the case it is to be anticipated that, although the sulphonic acids prepared from α-naphtoic acid and from α-cyano-naphthalene are both α-α-derivatives, the one will prove to be the 1 : 1' and the other (probably the cyano-compound) the 1 : 4' derivative. In any case, however, the behaviour of α-cyano-naphthalene affords another example of the modification of the "meta law" which prevails in the benzene series in favour of the "alpha law" to which reference was made in the previous report. These experiments on α-derivatives have been made by Mr. S. Williamson.

Dichloro-naphthalene-sulphonic acids.—With the object of characterising the dichloro-naphthalenes, and in order to obtain more material for the determination of the laws of substitution, a systematic study of the sulpho-acids obtainable from the dichloro-naphthalenes has been commenced and already extended to five of them by Mr. W. P. Wynne and myself; the examination of the dichloro-naphthalenes melting at about 61°, obtained from various sources, has afforded results of special interest, which serve to throw light on the constitution of several of the compounds referred to in the previous report, and has also led to the discovery that two distinct dichloro-naphthalenes have hitherto been confounded together.

1. It was suggested in the former report that the sulpho-acid formed from α-$C_{10}H_7Cl$ in small quantity, together with the 1 : 4 acid was an α-α-derivative; if, so, it should

* Second Report of the Committee, consisting of Professors Tilden and Armstrong (Secretary), appointed for the purpose of investigating Isomeric Naphthalene Derivatives. (Drawn up by Professor Armstrong). Presented to the British Association, Manchester Meeting, 1887.

give either the 1 : 1′ or 1 : 4′ dichloro-naphthalene on treatment with PCl_5. Actually, however, it is found to yield a dichloro-naphthalene melting at about 61°—the melting-point of Cléve's θ-modification—thus proving it to be an α-β-derivative.

Now there is reason to believe that, as a rule, if a β-hydrogen atom become displaced it is one contiguous to an α-position which is already occupied; it is therefore probable that the dichloro-naphthalene in question and the parent sulphonic acid are 1 : 2 derivatives. The acid obtained on sulphonating the dichloro-naphthalene gave a sulpho-chloride melting at 113°.

2. The chloro-acid obtained as chief product on sulphonating β-$C_{10}H_7Cl$ was said by Arnell to yield a dichloro-naphthalene melting at about 61° when distilled with PCl_5: on repeating the experiment, it was found that the product fused sharply at 65°. The sulpho-acid prepared from this dichloro-naphthalene gave salts similar to those obtained from the acid prepared from the dichloro-naphthalene discussed in the preceding paragraph, and its sulpho-chloride fused at 119°. A very small quantity of the products from α-$C_{10}H_7Cl$ was at disposal, but a very considerable quantity of those from β-$C_{10}H_7Cl$, which could therefore be carefully purified; and as the formation of a 1 : 2 derivative on sulphonating β-$C_{10}H_7Cl$ appears highly probable, it is believed that the slight differences observed were due to impurity in the products from α-$C_{10}H_7Cl$. It is thought desirable provisionally to term the dichloro-naphthalene melting at 65° *homo-θ-dichloro-naphthalene* = θ-$C_{10}H_6Cl_2$, as it is probably a *homo-nucleal* compound.

3. On treating the ? β-disulphonic acid, referred to in the previous report, with PCl_5, a dichloro-naphthalene is obtained which also melts at about 61·5°; this, however, yields a sulpho-acid distinct from that obtained from the dichloro-naphthalene from β-$C_{10}H_7Cl$, the melting-point of the sulphochloride being 150°.

4. Cléve has recently described a dichloro-naphthalene melting at 61·5° which he prepared from dichloro-α-naphthylamine. On sulphonating this modification an acid is obtained which is identical with that prepared from the dichloro-naphthalene from the ? β-naphthalene disulphonic acid. It is proposed to provisionally term this dichloro-naphthalene *hetero-θ-dichloro-naphthalene* = θ′-$C_{10}H_6Cl_2$, as there is reason to believe that it is a heteronucleal compound—probably it is 2′ : 4 $C_{10}H_6Cl_2$.

5. It will assuredly be found, on examining the two dichloro-naphthalenes melting (?) at 61° prepared from Cléve's two nitro-β-sulphonic acids, that the one is the *homo-* and the other the *hetero-θ*-modification. That obtained from Bayer's modification of β-naphthol-sulphonic acid is doubtless hetero-θ-dichloro-naphthalene: the conclusion arrived at by Claus, that this acid is a 2 : 3 di-derivative, is not only opposed to all that is known of the behaviour of naphthalene compounds, inasmuch as it involves the assumption that on sulphonating β-naphthol the second β-position contiguous to the hydroxyl becomes displaced; it is untrustworthy, as the dichloro-quinone which he obtained may have been, and doubtless was, produced by the action of chlorine liberated during the process of oxidation; and there is reason to believe that the dichloro-naphthalene corresponding to such an acid would be the ε-modification, which melts at 120°.

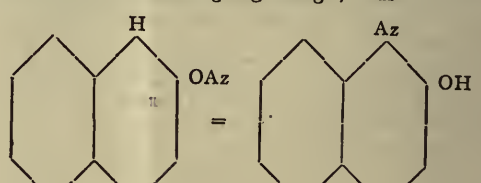
Isomeric change in the naphthalene series.—One of the most striking cases of isomeric change known is that of β-naphthyl-sulphate, $C_{10}H_7.OSO_3H$, into Schaefer's modification of β-naphthol-sulphonic acid by mere warming on the water-bath (*Berichte*, 1882, p. 204). The conversion takes place in the absence of sulphuric acid, and with such ease that there can be practically no doubt that it is a true case of isomeric change; and it is not probable either that the sulpho-group becomes displaced and re-enters the molecule in another position, or that one molecule acts upon another so that an exchange of sulpho-groups is effected. This view is supported by the following more recent observations: first, that if bromo β-naphthol be submitted to the action of SO_3HCl at ordinary temperatures, the resulting product contains very little of the sulphate $C_{10}H_6Br.O.SO_3H$, but chiefly consists of the bromo-naphthol-sulphonic acid, which is formed on brominating Schaefer's naphthol-sulphonic acid.

Again, if β-naphthyl-sulphate be acted upon by SO_3HCl without heating, not only is a second sulpho-group introduced, but that already present *spontaneously* changes its position: a *disulphonic acid* is thus produced which is characterised by the readiness with which it parts with one of its sulphonic radicles, being converted into Schaefer's monosulphonic acid; it is probable that the sulpho-group, which is easily displaced, occupies the α-position contiguous to the OH group. The disulphonic acid here referred to itself undergoes isomeric change when heated, but the nature of the product is not yet finally determined.

Lastly, experiments have been made at my suggestion by Mr. E. G. Amphlett, in which the formation of the sulphate has been prevented by ethylating the naphthol; and it appears that on sulphonating β-$C_{10}H_7.OC_2H_5$ at ordinary temperatures, by means of SO_3HCl, a mixed product is obtained, consisting chiefly of an acid which most probably is the ethylated derivative of Bayer's naphthol-sulphonic acid, together with a small proportion of what is undoubtedly the isomeric ethylated derivative of Schaefer's acid; if, however, the product be heated on the water-bath the former acid is converted into the latter.

These results afford evidence of a most interesting character, both the ease with which the conversion is effected and the variety of isomeric changes which are disclosed being remarkable. Special attention is being directed to the further elucidation of this branch of the enquiry.

Theory of the formation of azo dye-stuffs from β-naphthol.—A series of dye-stuffs of considerable technical value are produced from β-naphthol and its sulphonic acids by interaction with diazo-salts. It is well known that, in the case of β-naphthol itself, the α-hydrogen atom contiguous to the OH group becomes displaced by the azo-group. This position appears to be free in all the sulphonic acids which afford azo-colours, and those naphthol derivatives in which it is not free appear to be incapable of forming such colours; it is therefore a legitimate inference that all azo-dyes derived from β-naphthol are formed by the introduction of an azo-group in the position indicated. The formation of such azo-colours in all probability involves the occurrence of isomeric change, the initial action consisting in the displacement of the H atom of the OH group by the azo-group Az. the compound thus constituted then undergoing change; thus—



In the case of such compounds the isomeric change apparently can take place only in the one direction, and on this account it is impossible to effect the introduction of the azo-group into any other position; if it were possible to displace some other hydrogen atom, azo-colours might well result.

Melting-points of the isomeric sulpho-chlorides.—The following numbers are interesting, as showing that the same change in composition does not always involve a change in physical properties of the same order; it will be noticed that, whereas in the 1 : 4 series the bromo compound has a lower melting-point* than either the chloro- or iodo-compound, in the 2 : 3 series the bromo-

* The melting-point cited is that given by Jolin: the others are from my own observation.

derivative has the highest melting-point; the low melting-point of the 2 : 3′ iodo-sulpho-chloride is also remarkable.

	$\beta(1:4)$	$\theta(?1:2)$
α-Cl.$C_{10}H_6.SO_2Cl$	95°	127°
α-Br.$C_{10}H_6.SO_2Cl$	87°	151°
α-I.$C_{10}H_6.SO_2Cl$	123°	—
	$\epsilon(2:3')$	$\theta(?1:2)$
β-Cl.$C_{10}H_6.SO_2Cl$	109°	130°
β-Br.$C_{10}H_6.SO_2Cl$	125°	147°
β-I.$C_{10}H_6.SO_2Cl$	92·5°	174°

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

I HAVE carefully examined the details of the process which I have proposed for detecting frauds in butter adulteration. I do not see any reason to alter the general recommendation contained in CHEMICAL NEWS, vol. lvi., p. 222, for carrying out the test, nor am I able to add anything to make its indication more pronounced, but a few precautions, suggested by working, are necessary. Instead of using 10 grms., I find that 5 grms. are more convenient to work on; the removal of the solvent is accelerated.

Experiments have been mainly directed with a view of finding out:—

Firstly.— Whether any improvements could be introduced in the manipulative part of the process.

Secondly.—What may be expected by using other solvents than carbon disulphide, and the results likely to arise from the action of solvents themselves.

Thirdly.— The modifications which may, advantageously, be used to make the process approximately quantitative.

The influence of animal fatty substances on this reaction I propose to deal with more fully on a future occasion. I may just say that, by a modification of this process, important results seem possible, but as the fats and fatty principles will take some time to prepare, I thought it best to make this subject complete so far as vegetable oils are concerned.

It is necessary to say a few words on the action of sulphur chloride on oils generally. As these compounds are simply mixtures of definite chemical compounds, I prefer to use the terms yellow and dark instead of proto- and dichloride.

When the yellow chloride is added to oils a very violent action takes place; this action is more energetic if the dark chloride be used; on this account I simply regard these bodies mainly as convenient sources of chlorine.

The violent reaction prevents the oil being equally acted on, hence the necessity of mixing the chloride with some suitable solvent; the dark chloride will require diluting with a much larger quantity of solvent than the yellow chloride. The action on castor oil is so violent that a larger quantity of solvent should be used than for any other oil.

As a rule, if the yellow chloride be mixed with an equal volume of solvent it may be added to an oil without any turbulent action setting in. The solvent has an effect beyond its mere power of dilution; this enables it to be well mixed with the oil before the reaction sets in, and by its evaporation the mixture is kept cool and the reaction is more gradual; as soon as the sulphur chloride gets to a certain degree of concentration its action begins. It is not a necessity to expel the whole of the solvent until towards the end of the reaction.

In order to get rid of the obnoxious fumes, the reaction may take place in a small wide mouthed flask, instead of an open dish, and connected with a condenser. The flask is immersed in warm water to facilitate the reaction and to expel the solvent. It must be borne in mind that a portion of the sulphur chloride will pass over into the condenser with the vapour of the solvent. Carbon disulphide is not a pleasant solvent to work with on a large scale, but its use is indispensable, unless we are content to separate the butter fats, mixed with the water, which must be got rid of before adding the sulphur chloride.

If a porcelain dish be used as previously recommended, the residuum, after evaporating the disulphide, should be poured into a stout glass tube and corked, so as to prevent the excess of chloride depositing sulphur, through the moisture in the surrounding air.

Carbon disulphide being heavier than water, the dissolved fats pass only through the filter tube, a little disulphide is poured into the tube before adding the dissolved fats. If we use petroleum spirit, which is lighter than water, the water sinks and is consequently driven through with what it has taken up, in the way of curd and salt.

The presence of water is fatal to the distinctness of the reaction, as it decomposes the sulphur chloride. The uncertainty which is thus likely to be introduced must be provided for. In using petroleum for the subsequent part of the process it should be previously distilled with freshly powdered calcic oxide, so as to remove all traces of water. We must remember that petroleum and carbon disulphide may yield a cloudy mixture; hence, if carbon disulphlde be used for the first part of the process, it should be well driven off before adding petroleum, which, by-the-bye, does not dissolve sulphur so readily as disulphide, but with care no difficulty may be feared on this point.

Sulphur chloride cannot be diluted with any solvent containing water, as it is rendered cloudy; on account of this preference is given to carbon disulphide.

In considering the action of solvents a few important facts force themselves upon us. In my paper (CHEMICAL NEWS, vol. lvi., p. 222) I say that the thickened mass, in the case of genuine butter, dissolves perfectly in carbon disulphide; in the case of a vegetable oil being present we obtain a cloudy result. It is safer to note the consistency of the mass, which is unmistakeable when 5 per cent cotton-seed oil is added to pure butter; even 1 per cent could be hardly passed over. Care must be taken to perform these experiments in exactly the same way.

The cotton oil present in a sample of oleomargarine would of itself yield a distinct solid mass, but the animal oils or fats prevent this from their solvent action · it was from this result that I thought there might be a possibility of carbon tetrachloride being formed, which would retard the reaction. With the dark chloride this might be more likely to happen. The yellow chloride is free from this possibility.

These remarks lead us to consider a very important aspect of this matter.

The solvent action of the animal fats prevent our getting a solid mass due to the vegetable oil, but if we add to a suspected sample of butter a quantity of, say, cotton-seed oil, so as to render the quantity of animal fats, as a solvent, much smaller compared with the bulk operated on, we can not only separate out the oil we have added, but also the vegetable oil which previously existed in the oleomargarine.

We can in this way recover the animal fats which have been actually used in compounding the oleomargarine As animal fats and oils are acted upon by sulphur chloride, they are recovered in this changed condition, but by applying the washing process with carbon disulphide carefully, we can, by a process of fractionising, remove first the altered fat and then the unaltered fats, for they vary in their degree of solubility in carbon disulphide.

The quantity of sulphur chloride which I have recommended to be used is due to the fact that cotton-seed oil, in particular, requires a large quantity of chloride; however, if cotton-seed oil be present, a small quantity of chloride will give a pronounced cloudiness, but a

diminished thickening. The solvent action of the chloride cannot be disregarded when in large excess.

The process is best rendered approximately quantitative by adding to a known volume weight of the purified quasi butter fats about the same volume of cotton-seed oil, and after the reaction the increase in weight of the resulting mass when washed with carbon disulphide and dried will be due to the cotton oil present. Of course we ascertain beforehand what the added cotton-seed oil will yield. The oils which give this reaction with sulphur chloride give so far the same weight of product when an excess of sulphur chloride is used, that we shall not be far off the truth if we assume the figure given for cotton-seed oil as applicable to any other oil used in the manufacture of oleomargarine.

In my next communication on this subject I hope to give a complete numerical result, with details of working, on the quantitative examination of butterine.

The general results of the action of sulphur chloride on oils and fatty substances lead me to believe that the chemical constitution of these bodies is more complicated than we are at present inclined to think.

The glycerin in oils seems to be liberated in this reaction, and although this liquid is insoluble in carbon disulphide, it is removed by this solvent; this is probably due to the presence of other substances which are produced. If a large quantity of sulphur chloride be added, the glycerin is no doubt converted into chlorhydrins. This points to the conclusion that glycerin in oils and fats may be determined without the ordinary saponification treatment. Some altered oil contained in a tube was first washed with disulphide, then dried and subsequently treated with water which contained only a trifling amount of glycerin.

The matter extracted with disulphide is partially soluble in water, and yields an insoluble fatty compound with aqueous solution of potash. The absorption of bromine and iodine by this matter is very remarkable.

The bromide compound is prepared by dissolving iodine in bromine, in the cold, until all fuming ceases. The mass is dissolved in carbon disulphide, which is perfectly miscible with oils, &c. This compound has been made to give a medium reaction, for, as Chateau points out, bromine acts violently, whilst iodine is very slow. Instead of an aqueous solution I use one which is perfectly miscible with oils, and I have applied the same principle of using miscible solvents wherever practicable.

Fuming bichloride tin dissolves readily in carbon disulphide, and is always used wherever a reference has to be made to Chateau's reactions. I propose to deal fully with these matters in some papers which I prepared some time ago for the Chemical News, "On a New Method of Examining Oils, Fats, Resinous and other Allied Substances."

ON GRIQUALANDITE.

By BENNETT H. BROUGH, Assoc.R.S.M., F.I.C.

In no science is the tendency to introduce new names carried to such an extent as in mineralogy. It is, therefore, of interest, whenever a new name is proposed, to enquire whether that name is really necessary, and to determine whether the supposed new mineral is not essentially identical with one already known. An addition to the ever lengthening list of new mineral names has recently been made in the Chemical News, vol. lv., p. 240, by Mr. Grant Hepburn. The supposed new mineral gave on analysis:—SiO_2, 56·75; Fe_2O_3, 37·64; H_2O, 4·96; FeO, 1·09; MgO, 0·10. Mr. Hepbnrn regards it as a pseudo-morph after crocidolite, having the composition of a ferric silicate, $6SiO_2,4Fe_2O_3,5H_2O$, and assigns to it the name of griqualandite.

From the description of its physical properties, griqualandite appears to be nothing more than the well-known South African brown fibrous quartz, which, under the name of tiger's eye, is largely used as an ornamental stone. This fibrous quartz has been found by Renard to be not pseudomorphous after crocidolite, as is usually supposed, but formed by infiltration of quartz between the fibres of an altered crocidolite. The mineral analysed by Mr. Hepburn differs from the varieties of fibrous quartz analysed by Renard, in containing some 38 per cent less silica, and 33 per cent more ferric oxide. It, however, agrees perfectly with the analysis of brown fibrous quartz by F. Wibel (*Berichte*, vol. vi., p. 185). If the tiger's eye consists of quartz impregnated with ferric oxide and other materials derived from the alteration of the original crocidolite, there is no reason why every gradation, from crocidolite with 50 per cent of silica to pure quartz, should not be met with.

On considering Mr. Hepburn's analysis, it will be found that it corresponds more closely with the simple formula $H_2O.Fe_2O_3.4H_2O$, than with the complicated formula he gives. The percentage compositions demanded by the two formulæ are:—

	SiO_2.	Fe_2O_3.	H_2O.
$H_2Fe_2Si_4O_{12}$	57·42	38·28	4·30
$H_{10}Fe_8Si_6O_{25}$	56·80	37·80	5·33

It is thus seen that the analytical results agree satisfactorily with the composition demanded by the simple formula, with the exception of the percentage of combined water, which in the analysis is 0·66 too high. This may be due to experimental error. It is a curious fact that in all the published analyses of crocidolite, the widest variation is observed in the percentages of water, varying from 1·58 to 5·58. The formula $H_2O.Fe_2O_3.4H_2O$ for griqualandite is analogous to that of crocidolite, acmite, ægirine, and arfvedsonite, all of which have the formula $Na_2O.Fe_2O_3.4H_2O$. Griqualandite may therefore be regarded as a crocidolite in which sodium is replaced by hydrogen. It is not a pseudomorph after crocidolite, but rather a fibrous hornblende or uralite resulting from the alteration of that mineral.

THE ESTIMATION OF SILICON IN IRON AND STEEL.

By THOMAS TURNER, Assoc.R.S.M., F.C.S., F.I.C.

Mr. J. Jas. Morgan, in a note in the Chemical News, vol. vi., p. 221, has made some observations on my second paper on this subject (lvi., p. 49). So far as Mr. Morgan's experiments are concerned there is not so much difference between us as he appears to suppose. The irons analysed by Mr. Morgan always contained under 1 per cent of phosphorus, and generally under 1 per cent of silicon, the highest amount of silicon recorded by him being only 1·78 per cent. With such metal I am quite aware that it is easy to obtain fairly accurate results by any of the recognised processes of analysis. In my experiments no difficulty was experienced in the treatment of metal of superior quality, such as that mentioned by Mr. Morgan. But with commoner irons, often containing over 2 per cent of phosphorus and 3 or even 4 per cent of silicon, the case is different, as those who are in the regular habit of treating such metal will testify.

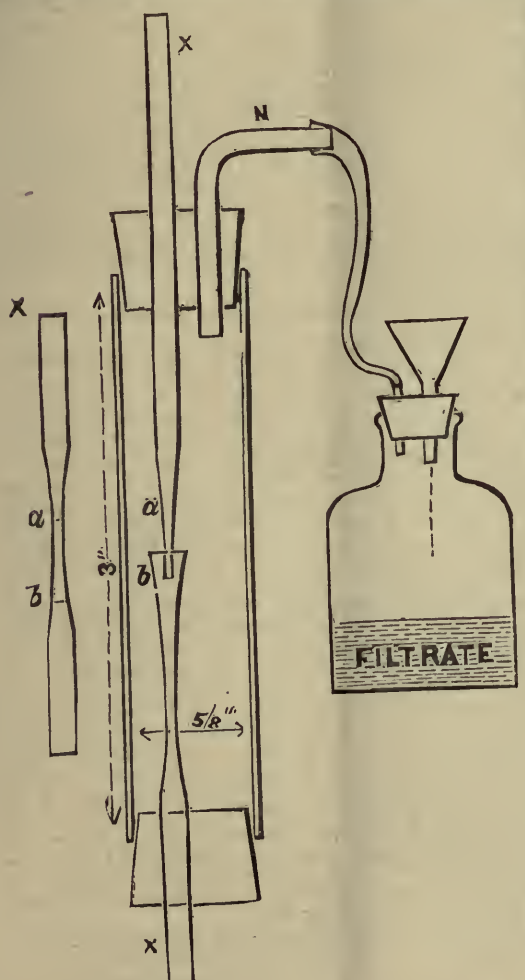
Mr. Morgan is, however, unnecessarily severe in one part of his criticism, which is as follows:—"Mr. Turner also states that with phosphoric irons containing titanium, the silica is contaminated with titanium. From this it is evident that Mr. Turner is ignorant of the fact, viz., that part of the titanium remains behind in combination with the silica, obtained by treating the iron with *aqua regia*, whatever the amount of phosphorus present, be it large or small." In the first place it should be mentioned that my words were as follows, when speaking of the residue obtained by evaporation with dilute *sulphuric acid* (not *aqua regia*). "With phosphoric irons containing titanium the silica is contaminated not only with iron

but also with titanic oxide and phosphoric acid. The residue may be very nearly white and still contain 20 per cent of substances other than silica." This, it will be seen, is quite different from the quotation given by Mr. Morgan. It is true I did not mention that on dissolving an iron containing titanium, in aqua regia, part of the titanium is obtained in an insoluble form. But Mr. Morgan is over hasty in attributing this omission to my ignorance; as a matter of fact I had known this for years, and as it is mentioned by every writer on the subject I have ever read, it seemed scarcely necessary to repeat it. Mr. Morgan states in the quotation above given, "that part of the titanium remains behind *in combination with the silica*." My own views, as expressed in my paper, were that under the circumstances mentioned the titanium existed in the form of a basic compound of iron, titanium, and phosphoric acid. At present I see no reason to alter this view.

SIMPLE FORM OF FILTER PUMP.

By ROBERT LAW.

A very simple and efficacious form of filter pump can be made as follows:—Select a piece of stout glass tube,



3" long and ⅜" bore; fit this with corks, one with two holes, the other with one hole. Now take three pieces of ordinary glass tubing $\frac{1}{10}$" bore, and draw two of them out as shown in Fig. 1; cut the one at *a* and the other at *b*; bend the third piece at an angle of 90°. Insert *x a* and the bent piece through one cork and *x b* through the other, so that *x a* will project inside of *x b*. Attach *x a* to a water supply. On allowing water to run through the apparatus a vacuum will be caused in the tube N, and, if connected as shown in sketch, filtering becomes a great deal more pleasant. I have found this apparatus to work very well: it gives a vacuum = 28·5" of Hg.

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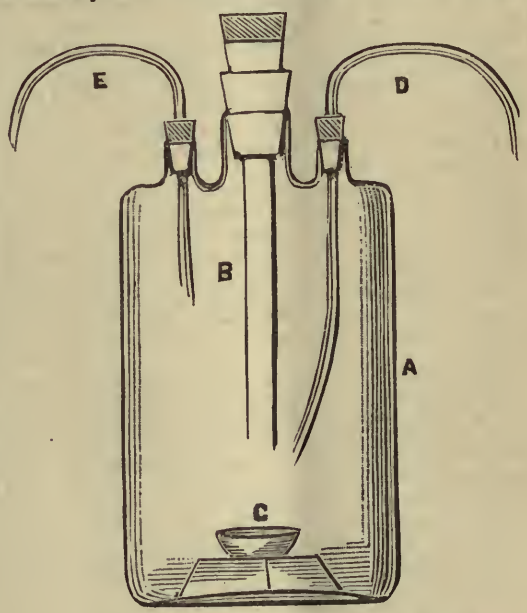
AN APPARATUS FOR PREPARING SULPHUROUS, CARBONIC, AND PHOSPHORIC ANHYDRIDES.

By H. N. WARREN, Research Analyst.

Having had occasion to prepare a quantity of sulphurous anhydride, for the purpose of reducing chromates previous to their analysis, I made use of the following apparatus, as represented in the accompanying figure:—It consists of a glass vessel, A, provided with three tubulars, otherwise resembling a large Wolff bottle, the large tube B being provided with a stopper for the purpose of introducing pieces of sulphur from time to time into the small dish, C, intended for its reception, and fed with air by means of the delivery tube, D, thus allowing the stream of gas



caused by the consumption of the sulphur to escape by means of the exit tube, E, to the vessel desired to receive it.

In using the apparatus the sulphur is first kindled by introducing a red-hot wire through the tube B, and replacing the stopper that has been momentarily removed for the introduction of the same. A slight blast is now maintained from the bellows that are in connection with the pipe D until the whole of the sulphur is thoroughly kindled, when a somewhat more powerful blast may be applied. When the apparatus above described is in full working order, from 2 to 3 lbs. of sodium carbonate may be converted into sodium sulphite in less than half an hour, or several gallons of water saturated. I have also, on connecting the apparatus with a powerful refrigerator

obtained in a short time a large quantity of liquid SO_2. It will be found advantageous, however, during the preparation of sulphurous anhydride, to employ a layer of water covering the bottom of the vessel to about 1 inch in depth. Carbonic anhydride and phosphoric anhydride may also be readily obtained in any desired quantity by slight alteration; but in case of phosphorus the air must be allowed to enter only gently, since a rapid current would at all times determine the fracture of the vessel.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES,

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Concluded from p. 235).

O. KORSCHELT (*Dingler's Pol. Jour.*, ccxxv., 158) suggested the use of potassic molybdate instead of ammonic molybdate. He prepared the solution by dissolving 1 part MoO_3 in 1 part KHO and 6 parts water, after cooling adding a solution of ½ part tartaric acid in 2 parts water, and finally 7½ parts nitric acid, boiling and filtering while hot. He dissolved the iron or steel in the smallest possible amount of boiling nitric acid, filtered, and added the heated solution to an excess of the molybdate solution in a capsule, also heated on the water-bath. He filtered on a balanced filter, washed with dilute HNO_3 and then with alcohol, dried at 120° to 130° C., and weighed. The precipitate contained 1·73 per cent P.

Boussingault (*Dingler's Pol. Jour.*, 1872, p. 223) used the fact of the insolubility of phosphate of cerium (pointed out by Damour and Deville) in HNO_3 in the determination of P_2O_5 in iron and steel.

Finkmer (*Deut. Chem. Ges. Ber.*, x., pp. 1638—1641) approved of Sonnenschein's method, and suggested the addition of an increased amount of NH_4NO_3, and the washing of the precipitate with a solution of ammonic nitrate and nitric acid. He washed the precipitate into a weighed crucible, evaporated off the water, heated it over wire-gauze to expel the NH_4NO_3, and weighed the ammonic phospho-molybdate. It contained 3·794 per cent P_2O_5.

E. Riley (*Chem. Soc. Jour.*, 1878, i., 104) recommended most strongly the acetate method, using $MgCl_2$ instead of $MgSO_4$ in his magnesia mixture, and citric acid to keep the Fe_2O_3 in solution. He considered a large amount of citric acid necessary. He allowed the solution to stand over night before stirring, then stirred vigorously, and allowed to stand for twenty-four hours before filtering off the precipitate of $Mg_2(NH_4)_2P_2O_8$. He suggested, also, a combination of the acetate and molybdate methods by dissolving the acetate precipitate in HCl, adding excess of NH_4HO, acidulating by HNO_3, and precipitating by ammonic molybdate, filtering and weighing the phospho-molybdate of ammonia.

For the determination of P_2O_5 in iron ores, iron, and steel there are practically but two methods in general use at the present day—the molybdate and the acetate—unless we consider a combination of the two as a separate method. Each has its ardent admirers, but the general opinion among chemists of experience is, that either method will give accurate results if proper care and skill are used in carrying out the details of the work. I propose to point out those details which require special care in each method, and want of attention to which may cause serious errors in the results. The presence of titanic acid, unless the precautions mentioned in the method given in my report for the determination of P_2O_5 are observed, will be a fruitful source of error in either, and arsenic acid, unless carefully separated, will cause too high results whichever method be used.

1. In the molybdate method the first point to be observed is the destruction of the carbonaceous matter, especially in the case of irons and steel. I first observed this in 1877 in an investigation of Korschelt's method, which is mentioned in a paper by Hunt and Peters (*Metallurgical Review*, vol. ii., p. 365) to whom I communicated the fact in 1878. Finkmer (*Deut. Chem. Ges. Ber.*, x., pp. 1638—1641) mentioned the same thing in the same year, and says, very truly, "0·10 per cent of P in a steel may easily be entirely overlooked by inattention to to this fact."

2. If the solution of the steel or iron in HNO_3 is evaporated to dryness, and the residue is ignited to destroy carbonaceons matter, it must be re-dissolved in HCl, for very often the ignited ferric phosphate is quite insoluble in HNO_3. This requires repeated evaporations with HNO_3 to get rid of HCl, which is considered deleterious by such analysts as Fresenius and Finkmer.

3. Silica must be removed from the solution before adding the molybdate solution, unless the P_2O_5 be finally precipitated as $Mg_2(NH_4)_2P_2O_8$.

4. After adding the molybdate solution, great care must be exercised on two points—the degree of acidity and the temperature of the solution. The phospho-molybdate of ammonia will not precipitate readily if the solution is too acid or the temperature too low, and a continued high temperature or boiling of the solution tends to the precipitation of an excess of molybdic acid with the ammonic phospho-molybdate. The most careful analysts direct that the solution should stand from six to twenty-four hours before filtering, and that the filtrate should always be tested by a fresh addition of molybdate solution.

5. If the P_2O_5 is finally weighed as $Mg_2P_2O_7$ it is very difficult to get rid of the last traces of molybdic acid. After two precipitations as $Mg_2(NH_4)_2P_2O_8$, I have found appreciable amounts of MoO_3 in the HCl solution of the ignited $Mg_2P_2O_7$.

In the acetate method the first point which requires special attention is:—

1. Driving off the excess of SO_2. It is very necessary to do this, as ferric phosphate is soluble in SO_2 and in ammonic sulphite.

2. Both care and experience are necessary in neutralising the deoxidised solution, for all the free HCl must be neutralised, and enough NH_4HO added to precipitate all the ferric phosphate and ferric oxide, and an excess over this should be avoided as tending to obscure the reaction and causing an excess of ammonic acetate, which is deleterious. On the other hand, if all the Fe_2O_3 is not precipitated, there will be loss, for ferric phosphate is soluble in ferric chloride.

3. The precipitate of ferric phosphate and oxide should not be washed much (one washing is ample), as ferric phosphate is decomposed by pure water. My own personal preference is for the acetate method, and for the following reasons:—1. The sources of error are fewer and are more easily guarded against. 2. If the proper precautions are taken in each method, the acetate is the quicker. I have made many determinations (the accuracy of which was afterward proven by other results) in iron ores in twenty-four hours and in steels in forty-eight. 3. There is not the same temptation in the acetate method that there is in the molybdate to take short cuts, which has brought many a young chemist to grief. 4. Experience has shown* that the molybdate method, as practised by many chemists, is not as accurate although it may be shorter than the acetate.

An accurate determination of P_2O_5, by whatever method it is made, requires much skill and not a little practice, and the advocate of one method often makes the other

* From "Mining Industries of the United States."

* E. Riley, *Jour. Chem. Soc.*, 1878, i., 104, besides numerous cases which have come under my own observation.

suffer in comparison, more by reason of his own want of skill in the manipulation of the other method than by reason of any great advantage inherent in his own.

ON THE EFFECTS PRODUCED BY SMALL QUANTITIES OF BISMUTH ON THE DUCTILITY OF SILVER.

By Surgeon-Major J. SCULLY, Assay Master, Calcutta.

(Concluded from p. 234).

III. We have now to consider the best way of dealing with silver tendered for coinage which is proved to contain bismuth; and a few remaining points.

The only experiment on a large scale for refining such silver here, as far as I know, has already been described. The want of success which attended it seemed to be due to the very small amount of base metal in the bullion, for the formation of a slag in which the bismuth oxide could be entangled and removed by skimming, and possibly the reducing action of the plumbago pots used may have added to the difficulty. As it seemed certain, however, that nitre would effect the desired oxidation of the bismuth, some experiments were tried in this direction on a small scale. About 20 troy ounces of silver containing 2·5 per mille of bismuth, and no other metal in appreciable quantity, was melted in a *clay* pot and repeatedly treated with nitre and borax, the bath being skimmed from time to time. After prolonged treatment in this way, the fineness of the silver being three times tested by a dip assay, the report on the silver was raised from 997·5 to 999·2; so that there can be no doubt that bismuth may be removed in this way. But the process, as several experiments showed, is tedious, and of course is attended with a loss of silver which in large operations would be of notable amount. Considering, therefore, that silver containing bismuth has hitherto only been met with at the Mint in bars of high fineness, and that these are not readily refinable by the ordinary process, it would seem as well, if such silver be accepted at all, to deal with the bismuth in it by the plan of *dilution*. The proportion of bismuth any silver contains being ascertained, it may, if convenient, be mixed by melting with sufficient silver free from bismuth, and with copper, so as to reduce the proportion of bismuth in the coinage bars to less than 0·5 per mille, and thus neutralise its injurious effects on the ductility of the bars.

The explanation of small quantities of bismuth being found in refined silver—*i. e.*, silver which has undergone parting for the extraction of the gold which was contained in it—seems sufficiently indicated in the following extract from Dr. Percy's work ("Silver and Gold," Part I., p. 474), where that author is referring to the experience of Dr. Rössler in parting silver;—"Bismuth has been found in nearly all kinds of silver; but in parting by sulphuric acid it is lost *partly in the fine silver* and partly in the slags." The italics are mine. That small quantities of bismuth adhere very tenaciously to silver, when once mixed with that metal by melting, is shown by the following experience:—A quantity of silver containing bismuth, which had accumulated from the laboratory experiments before detailed, was melted, granulated, dissolved in nitric acid, and the silver precipitated as chloride. The silver chloride, after repeated washings, was reduced by heating in a plumbago pot with chalk and charcoal. The resulting ingots, on assay, showed at once that bismuth was still present in them in very appreciable quantity.

It may here be of interest to mention that I have found about 0·7 per mille of bismuth in some old Hindu punched coins, forming part of a treasure trove which was found at Chaibassa, in the Singhbhum district.

The following is a summary of the main results detailed in this paper:—

1. The Indian assay process for silver bullion is, incidentally, a delicate qualitative test for the presence of bismuth in such bullion.

2. The assay process can be readily modified so as to give accurate results in the presence of such proportions of bismuth as are likely to be encountered in practice.

3. Fine silver when alloyed with only 1 per mille of bismuth has its ductility sensibly impaired thereby; and 1 per cent of bismuth is sufficient to render fine silver, or alloys of it with copper down to 906 fine, extremely brittle.

4. Fine silver alloyed with small quantities of bismuth, and silver-copper alloys down to 980 fine when containing small proportions of bismuth, have the remarkable property of being more ductile when rapidly cooled in water after casting than if allowed to cool very slowly, thus resembling bronze in this respect.

5. Coinage bars such as are used in the Calcutta Mint, and with the procedure there adopted for rolling, are quite unfit for coinage, owing to brittleness, if they contain only 3 per mille of bismuth, while if the latter metal forms less than 0·5 per mille of the whole mass the ductility of the bars is not much affected.

In conclusion, I have much pleasure in recording my appreciation of the services of Messrs. J. R. L. Durham and E. Hood, Head and Second Assistants in the Assay Office, in carrying out under my directions many details of the experiments recorded in this paper.

Calcutta, March, 1887.

PS.—June 10th. The experiments detailed in the foregoing paper were completed early in November, 1886, and it was proposed to embody the conclusions formed in an official report to be submitted this year. It was suggested to me, however, that the subject investigated might be of general interest, and I had determined to publish this paper when I noticed in the Chemical News of March 21st, 1887 (p. 137), a short abstract of a paper on "Silver containing Bismuth" by Messrs. Gowland and Koga, of the Japan Mint. I have delayed presenting this paper until I had read the full text of the communication from Japan (*Journal of the Chemical Society*, No. ccxciv., May, 1887, p. 410), and I may now make a few remarks upon it in connection with what I have advanced.

Messrs. Gowland and Koga's very interesting paper to a great extent covers ground which I had not investigated, viz., the want of uniformity in composition of silver bullion containing bismuth. This part of the subject was suggested to me for experiment, as some of my results seemed to show that bismuth mixed with silver by melting and careful stirring does not diffuse itself evenly throughout the solidified mass. But that fact, now proved by Messrs. Gowland and Koga, was of no practical importance to us in the assay and valuation of bullion, seeing that it is an invariable rule now in the Calcutta Mint to pre-melt and assay by a granulated sample *every* kind of bullion tendered to the Mint,—from refined bars 999·5 fine to Mexican dollars. The well-known want of homogeneity in solidified silver-copper alloys, and other contingencies to which silver bullion is subject, render this course imperative for purposes of valuation on any extended scale. The cutting of samples from silver bullion for assay, even if the spot where such samples should be cut has been determined after most laborious investigation, can at best give merely approximate results,—as indeed our authors admit for the case of silver containing bismuth.

With regard to the toughening or refining of silver containing bismuth, Messrs. Gowland and Koga mention that this operation is successfully performed in the Japan Mint by prolonged exposure of the molten metal to the oxidising action of the air, aided in some cases by the use of nitre. This may seem at variance with our experience here, but is probably not so after all. The brittle bullion treated in Japan evidently contained a considerable amount of base metal in addition to the bismuth, the

slags formed in the early stages of the melting consisting chiefly of litharge, &c. What we had to deal with was refined silver 990 fine, and in this case of course it would be more difficult to free the bullion from bismuth than if lead and other base metals were present in sufficient quantity to form a copious slag. But in any case (without, however, venturing to give any authoritative opinion on the subject) I doubt whether the Indian Mints would willingly undertake any considerable refining operations on bullion. The conditions under which these Mints receive bullion are very different from those obtaining in the case of the American and Australian Mints, and the Imperial Mint of Japan. In those countries encouragement has to be given to native mining industries, and hence a good deal of work in the way of purification and separation of metals is undertaken by their Mints. In India practically all the bullion is imported by banks and merchants, from Europe, America, and elsewhere, and tendered to the Mints for coinage at a fixed charge. The Indian Mints may therefore, as in the case of the Royal Mint in London, very properly require that all bullion tendered to them shall be free from taint of brittleness, and so far fit for coinage. It is for the importers to make sure that their purchases are satisfactory in this respect.

As to the amount of bismuth that will render silver brittle, my results seem to be substantially in accord with those of Messrs. Gowland and Koga. They found that pure silver alloyed with only 5 per mille of bismuth was very brittle; the casting, I suspect, was allowed to cool slowly. Coinage bars of 900 fine, containing nearly 14 per mille of bismuth, were brittle and altogether unfit for coinage, as I should have expected. But by special treatment in the way of repeated annealings, some of these bars were rolled down successfully without cracking, although they still could not be used for coinage.

In the other matters treated of in my paper the results obtained will supplement those of my *confrères* in Japan.

OBITUARY.

THE LATE PROF. T. S. HUMPIDGE, Ph.D., B.Sc.

Last week we had to record the death of a chemical veteran, Prof. Bloxam, on the 29th ult., and now we are grieved to chronicle the death, on the following day, of Prof. Humpidge, of the University College of Wales, in the prime of life and promise, at the early age of 34.

Dr. Humpidge did not begin his strictly chemical career until he was twenty-one, having passed the previous seven years of his life in a corn merchant's office in Gloucester, of which town he was a native. But during this time he had been attending the evening classes at the School of Science and Art, and this so successfully that the Science and Art Department offered him a free place at the Royal College of Chemistry, and £50 per annum for two years. With this assistance he went up to London in 1874 and studied for some time under Professor Frankland, who in 1875 selected him as one of the Jodrell scholars. In 1876 he went to Heidelberg, where he worked under Prof. Bunsen. After taking his Ph.D. there he was appointed, in 1878, science master at the De Fellenberg Institute, Hofwyl, near Berne, and in 1879 was elected to the chair of chemistry at Aberystwyth.

At South Kensington he carried out an investigation on the coal-gas of the metropolis, and at Heidelberg worked with Mr. W. Burney on yttrium and erbium. But his most important work was performed at Aberystwyth. Whilst there he made very careful determinations of the specific heat, at different temperatures, of specially purified beryllium. He also made determinations of the vapour densities of the chloride and bromide of that metal. And although the publication of his vapour density determinations was somewhat forestalled by that of the work of Nilson and Petterson, his work was still of great importance in helping to settle definitely the moot question of the atomic weight of beryllium, and to show that here again the periodic system was a correct indicator in the classification of the elements.

Later on work was commenced on the accurate redetermination of the specific heats of various metals. But the disastrous fire at the college in July, 1885, not only put an end to this research by the destruction of laboratory, apparatus, and materials, but by the shock it gave his system undoubtedly largely contributed to the development of the disease to which Prof. Humpidge eventually succumbed. After another session's work the break down of the nervous system was so complete that he had to ask for leave of absence from his professorial duties. A year's rest seemed to have done so much that hopes were entertained of perfect recovery at no distant date, but the improvement was only transitory. A few weeks ago he became rapidly rapidly worse again: in a few days he took to his bed, and then the end came on apace, his death occurring from cerebral deterioration.

As a teacher as well as an investigator Dr. Humpidge was most successful, and his loss will be much felt by students, colleagues, and friends. In 1880 he married Fräulein Johanna Ruder, of Oldenburg, and by her had three sons, the eldest of whom died about two years ago.

He was buried with full academic honours in the churchyard at Llangorwen, near Aberystwyth, on December 3rd.

THE LATE C. L. BLOXAM.

A few additional particulars concerning the career and researches of this chemist may not be unwelcome to our readers.

Charles Loudon Bloxam, the son of a London physician, was born March 23rd, 1831. He was a pupil of the King's College School in the years 1842-3, and in 1845 he entered the Royal College of Chemistry, and the next year he was admitted to the position of a gratuitous student. Prof. Hofmann, in his first report to the Council of the College of Chemistry, speaks of him in these words:—"Mr. Bloxam is a youth of 16 years of age, but his zeal and perseverance inspire me with best hopes for his future progress."

In 1849 Bloxam became an Assistant in the Royal College, which he finally left in the year following. In 1854 he was appointed Demonstrator of Chemistry at King's College. In the same year he was elected a Fellow of the Chemical Society. On the death of Prof. Bowman, in 1856, he became Professor of Practical Chemistry at King's College, and in 1870 he succeeded Prof. W. A. Miller in the Chair of Chemistry. From 1855 to 1882 he held the position of Lecturer on Chemistry and Physics at the Royal Military Academy, an appointment which he resigned owing to certain changes in the management of the Academy which he thought to be degrading to Science. He drew attention to the matter in a pamphlet which received some notice at the time.

He communicated the following papers to the Chemical Society:—In 1857, in conjunction with Sir F. Abel, "Contributions to the History of Nitric Acid with reference to the Valuation of Nitre." In 1858, "On the Juice of Beef." In 1860, "On the Action of Boric Acid upon the Carbonates of the Alkalies and Alkaline Earths." In 1861 he contributed papers on "The Application and Electrolysis to the Detection of Poisonous Metals in Mixtures containing Organic Matter;" "On the Crystalline Hydrates of Baryta and Strontia;" and "On the Electrolytic Test for Arsenic in the Presence of that Metal in Certain Reagents."

In 1862 he wrote "On the Amount of Water displaced from Hydrates of Potash, Soda, and Baryta, by Boric and Silicic Acids." The following year the *Journal* of the society contains his researches on the source of

arsenic in commercial sulphuric acid, and on the preparation of that acid free from arsenic. In 1865 he contributed three papers:—"The Action of Chlorine upon Arsenious Acid;" "The Action of Hydrosulphate of Ammonia upon Copper Sulphide, previously precipitated;" on "General Routine of Qualitative Analysis for Metals;" "Qualitative Analysis of Substances insoluble in Water and Metals;" and "Detection and Qualitative Separation of Tin, Antimony, and Arsenic." To his Valuable contributions to the Chemical News we have already referred. The first edition of his "Chemistry, Inorganic, and Organic," appeared in 1866, and his "Laboratory Teachings" in 1869.

NOTICES OF BOOKS.

Proceedings of the Ninth Annual Meeting of the New York State Pharmaceutical Association, held at the Thousand Island Park, June 21st, 22nd, and 23rd, 1887. New York: Elmira.

The first thing we notice in these Proceedings is a list of questions to be answered at the next yearly meeting. One of these calls attention to a spurious glycerin, consisting of a saturated solution of magnesium sulphate with about 15 per cent of glucose. Such a mixture would possess none of the useful properties of glycerin, but it is described as being deceptive in appearance and as having the specific gravity 1·26.

Another query is "What power has filter-paper of withdrawing alkaloids from solution?" It is suggested that analytical determinations, as regards the more important alkaloids, would be of value.

Question 14 reminds us of a piece of information placed in our hands, of which, pending its verification, we have not been able to make use. The query is "What proportion of arsenic do the arsenic complexion wafers of the market contain, and is their use prejudicial to health?" Here, then, we have the implied assertion that arsenical wafers are sold as cosmetics, the only points raised being the exact proportion of arsenic thus introduced, and its possible effects on the human economy. We should like to know whether similar preparations are sold in Britain?

One of the speakers at the general meeting of the Association quoted the wish of an eminent physician that all the quacks could be killed in one day, but added that such a general slaughter would be of no use, since the demands of human nature would raise as large a crop on the morrow.

From a debate on the adulteration of drugs we learn that adulteration is fairly rife in America. From the hesitation to publish the names of the vendors of spurious or inferior articles, we learn that there, as well as in England, the Libel Law is the quack's sword and shield.

Dr. R. G. Eccles has made some interesting experiments on the action of boric acid upon microbia. He finds that as an antiseptic there can be no doubt of its value, whilst as a disinfectant it is worthless and displays no signs of germicidal power.

The question of the alleged purity of ice and ice-water has been very thoroughly sifted, and the ordinary view—though suggested by such eminent authorities as Prof. Tyndall and the late Dr. W. A. Miller—is found to be quite untenable. Ice, from a solution of 0·83 grm. urea per 100 c.c. of distilled water, was found to retain 0·50 grm. of the impurity to the same volume.

When every 100 c.c. contained 1·5 grm. of glucose, the same volume of ice was found to contain 0·96 grm. Arsenic dissolved in ammonia, and then diluted until 1 litre contained 1·78 grms. of the poison, and then frozen, was found to contain 0·48 grm. in ¼ litre of ice.

Professor Nichols, in his Report to the Massachusetts State Board of Health for 1882, says (p. 289)—"Freezing is a form of crystallisation, and the general rules apply only so far as inorganic pollution is in question. Ice frozen from water, holding in solution mineral salts, will contain less of these than the water from which it was originally frozen, and by repeatedly dissolving in distilled water and re-freezing nearly all inorganic impurities can in time be eliminated from the ice. But in case of organic pollution the reverse is true. Often the process of freezing may and does concentrate such impurities, so that the ice contains more in a given weight than the water from which it was frozen."

Pathogenic germs, as a matter of course, are not in the least affected by freezing, and thus several epidemics in the United States have been traced to the use of ice, which, if obtained from rivers or lakes into which sewage can penetrate, should always be viewed with grave suspicion. The sewage of Troy and Albany, in which two cities the yearly average of deaths from typhoid fever is 75, flows into the Hudson, whilst most of the New York ice simply comes from the river *below* the same cities.

The volume before us contains much other interesting matter to which space, or its deficiency, does not permit us to draw attention.

CORRESPONDENCE.

TESTING OILS.

To the Editor of the Chemical News.

Sir,—Mr. Allen has pointed out to me that he considers that the last paragraph but one in my article on "Butter Examination," which appeared in the Chemical News, vol. lvi., p. 222, has an offensive reference to himself.

Mr. Allen says that "he regards this paragraph as practically stating that I suppose Mr. Allen's object in recently condemning chloride of sulphur for the purpose of testing oils was that it clashed too severely with the interests of the oil trade, and I protest against Mr. Allen using his position as an ægis for the questionable practice of others.

I wish to say that although Mr. Allen and myself have lately been at variance on certain points in connection with this matter, that I have too high an opinion of Mr. Allen to apply such remarks to him, and I feel sorry that Mr. Allen should have thought that I could allow my judgment to be warped by a spirit of such reckless vindictiveness.

Chloride sulphur has been repudiated, by some people, as being of no use in testing oils, and this remark, I am told, has been backed up by scientific references; it was this knowledge which called for the remark referred to.

To no class of men is the cultivation of a high moral tone more essential than to chemists. No one, more than myself, can wish for promoting a temperate and kindly feeling between those who enter the arena of debate; it is far better to err on the side of leniency than to drift the other way.—I am, &c.,

Thomas T. P. Bruce Warren.

Tamworth Villa, Earlham Grove,
Forest Gate, E,

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 20, November 14, 1887.

Condition of Potassa in Plants and in Soils and on its Determination.—MM. Berthelot and André.—In a living plant potassa may be distinguished as existing in

three states—the one easily soluble in water and transmissible by circulation and diffusion; the second not readily transmissible by pure water, but capable of becoming so by the action of acids; the third more resistant, and not readily displaced. The quantity of potassa extracted by acidulated water differs little before and after incineration. But the proportion removed by water alone was much larger before than after ignition. This latter cannot serve as a measure of the quantity which pre-existed in the living plant or in the soil.

On a New Method of Forming Safranines. — Ph. Barbier and Leo Vignon.—Pheno-safranine and its homologues may be obtained by the reaction of various para-amido-azo-derivatives (amido-azo-benzol and amido-azo-toluol) upon the mono-nitro-mono-benzinic carbides in presence of reducing agents.

Action of Sulphuric Acid upon Mixtures of Morphine and Bibasic Acids.—P. Chastaing and E. Barillot.—On dissolving morphine in an excess of dilute sulphuric acid, and evaporating this liquid until white fumes appear, we obtain sulpho-morphide, a body of a variable composition, and which gives a brown product if treated with concentrated alkalies. Other novel compounds are obtained on adding to the above mixture a diatomic and bibasic organic acid, such as the oxalic, the malonic, or the succinic. These compounds are white when dry and freshly prepared; they do not crystallise, and on exposure to air, especially under the influence of light, they turn greenish. They are insoluble in most neutral solvents, sparingly soluble in cold water, but moderately soluble in boiling water. They behave in general like polyvalent phenols.

Journal fur Praktische Chemie.
New Series, Vol. xxxv., Part 8.

On Oxy-stearic Acids of Different Origin.—M., C., and A. Saytzeff.—The oxy-stearic acid at present known belongs to the β-hydroxy-acids, an assumption which agrees with its behaviour on distillation, when it is resolved into water, and a non-saturated acid of the composition $C_{18}H_{34}O_2$, the latter consisting chiefly of solid oleic acid.

The Transferrers of Halogens in the Natural Groups and Periods of the Elements.—C. Willgerodt. —The author gives a table of the transferrers of halogens as arranged in their natural groups and periods. The most suitable elements for the transfer of halogens are gold, aluminium, gallium, indium, thallium, zirconium, tin, antimony, bismuth, tellurium, iodine, and iron.

On Free Thiocyanic Acid and Cyanic Acid and their Combinations with Ether and Alcohols.—P. Klason. — The author describes hydrocyanic acid, anhydrous and hydrated, their preparation and properties, the molecular combinations of hydrogen sulphocyanide with other bodies, and lastly cyanic acid and its combination with ether.

Remarks on the Addition of Ethyl Malonate to Bodies with a Two-fold Carbon Band.—L. Claisen.—A critique on a memoir by A. Michael (*Jour. Prakt. Chem.*, vol. xxxv., p. 349).

On Halogen-benzol-haloids, especially on α-Trichlor-benzol-hexachloride.—C. Willgerodt.—This compound is colourless, not readily crystalline, of a penetrating and very persistent odour, like putrid straw. The melting-point is between 95° and 96°. It dissolves readily in the cold in ether, chloroform, benzol, ligroine, carbon disulphide, and glacial acetic acid; less readily in alcohol.

Part 9.

Contributions to the Chemistry of the Cobalt-ammonium Compounds. — S. M. Jörgensen. — An elaborate study of the luteo-cobalt salts.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Removing Ink Stains.—I have been for many months past decorating an album, and was unfortunate enough to smear one of the leaves with printers' ink. Can you tell me whether there is any chemical that I can use to remove the stain from the paper (it is of fair thickness) without leaving any mark or injuring it?—J.R.W.

MEETINGS FOR THE WEEK.

MONDAY, 12th.—Medical, 8.30.
—— Society of Arts, 8. "The Elements of Architectural Design." by H. H. Statham.
TUESDAY, 13th.—Royal Medical and Chirurgical, 8.30.
—— Institution of Civil Engineers 8.
—— Photographic, 8.
WEDNESDAY, 14th.—Society of Arts, 8. "Commercial Education, by Sir Philip Magnus.
—— Pharmaceutical, 8.
—— Microscopical, 8.
THURSDAY, 15th.—Royal, 4.30.
—— Chemical 8. "An Apparatus for Comparison of Colour Tints," by A. W. Stokes. "The Sulphonation of Naphthalene," by Dr. Armstrong and W. P. Wynne, B.Sc. "Isomeric Changes in the Naphthalene Series" Nos. I. to IV., by Dr. Armstrong and Messrs. Amphlett, Williamson, and Wynne. "Notes from the Chemical Laboratory of the Yorkshire College, Leeds. (1) The Reduction of Chlorates by the Copper-Zinc Couple. (2) The Oxidation of Oxalic Acid by Potassium Bichromate. (3) A Method of Separating Supernatant Liquids," by C. H. Bothamley. "The Alloys of Copper and Antimony and of Copper and Tin," by E. J. Bell, Ph.D.

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MINERALS.
PROF. A. E. FOOTE, of Philadelphia, will complete filling the orders that he now has in hand Dec. 9th, and will complete packing what remains Dec. 15th. He can therefore fill orders for blowpipe and his systematic collections at the American Exhibition till that date.
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THE CHEMICAL NEWS.

Vol. LVI. No. 1464.

DETERMINATION OF PHOSPHORIC ACID IN CONTAMINATED WATERS.

By Dr. T. L. PHIPSON, F.C.S., Lond., &c.,
Member of the Society of Chemical Industry.

This note is a little supplement to the analyses of waters and observations thereon published by me in the Chemical News in 1878 and 1879, where, among other things, a method of determining urea in contaminated waters was made known. In the present instance I allude to an easy and rapid method of determining phosphoric acid in similar circumstances, which I imagined not long since whilst making a series of water analyses for the Portuguese Government, and found it of considerable service.

It is well to remark that in pure waters, fit for domestic use, I have never found phosphoric acid present except in the *most minute traces*, even in waters from deep wells; and in many mineral waters it can only be determined in the residue left on evaporation. But with contaminated waters it is different; in these phosphoric acid is always present, and can be detected in the water itself by the following means:—

To about a pint of the water a very small quantity of solution of pure potash alum is added, and then a drop or two of ammonia. Without separating the precipitate, the water is rendered distinctly acid by addition of pure acetic acid; the phosphate of alumina remaining is separated, dissolved in nitric acid, and the phosphoric acid determined by the ordinary molybdate test.

By this method very minute quantities of phosphoric acid can be concentrated and isolated, and determined both qualitatively and quantitatively.

London, Dec. 10, 1887.

NOTE ON THE ACTION OF SEA-WATER UPON CAST-IRON.

By CARTER NAPIER DRAPER.

The results of the long-continued immersion of cast-iron in sea-water are well known, and examples may be found in most of the books of reference. The most frequently cited instance is perhaps that related by Berzelius,* of cannon balls which were raised at Carlscrona from a ship sunk for fifty years, and which had become converted through one-third of their mass into "a porous graphitic substance, which became strongly heated when exposed to the air for a quarter of an hour." The chemical change which cast-iron undergoes under these circumstances is usually stated to consist in the removal of the greater part of the iron, the residue consisting of graphite and a graphitic substance, FeC_3.

I have recently been indebted to the kindness of Mr. John P. Griffith, C.E., of the Dublin Port and Docks Board, for a specimen of grey cast-iron which was broken from an old rail taken from a graving slip in the Port of Dublin, and believed to have been laid in 1833. The rail was at about half-tide level, and it may be therefore assumed that it was for twenty-five years immersed in sea-water, and for a like period exposed to the action of the atmosphere. The fragment of iron weighed 557·31 grms., and measured 85 by 52 m.m., with a depth of 20 m.m. On its lateral surfaces it was slightly encrusted with sesquioxide. The upper surface, for a depth of 7 m.m. had been converted into a brown-grey graphitoidal substance, which was without difficulty removed with a knife, leaving the surface of the iron bright and free from any adherent coating. During the operation of removing the easily pulverulent layer, the mass of iron became hot,—not hot enough to cause inconvenience in handling, but hot enough to enable it to be very sensibly warm to the touch after the lapse of half an hour.

The quantity of altered cast-iron thus removed weighed 67·59 grms., and was examined with the following results:—It was wholly attracted by the magnet. Treated with dilute hydrochloric acid it evolved hydrogen, giving a pale green solution of ferrous chloride and a residue of graphite. The carbon was determined by the method of Weyl. The finely powdered substance, with excess of strong hydrochloric acid, was placed in a platinum dish, connected with the positive element of two Smee cells, while a platinum wire terminal from the negative dipped into the liquid. After twenty-four hours the contents of the dish were transferred to a filter, washed, dried, and weighed: 2·66 grms. of substance gave a carbon residue weighing 0·631 grm. = 23·6 per cent of carbon. By the reaction with free iodine abundant evidence of the presence of unoxidised iron (doubtless existing as FeC_3) was obtained.

Dublin, December, 1887.

* *Gmelin's Handbook*, vol. ccxviii

NOTES ON A NEW ZEALAND SULPHUR ISLAND, AND SOME REMARKABLE FORMS OF NATIVE SULPHUR.

By R. W. EMERSON MACIVOR, F.I.C., F.R.G.S., F.C.S., &c.

The wonderful little island known as White Island, in the Bay of Plenty, is part of the crater of a huge conical mountain which has long since been submerged. It lies about 50 miles east of Tauranga, and 20 miles out of the usual track of vessels crossing the bay between Cape Colville and East Cape. Sir J. Hector, F.R.S., the eminent Director of the Geological Survey of New Zealand, who visited the island in 1870, described it as a horseshoe-shaped range of mountains, having an altitude of from 800 to 900 feet. It had much the same shape and height when I explored it some thirteen years later, but at least half of it disappeared into the sea during the violent and disastrous volcanic disturbances in the northern part of the colony a year or two ago.

I cannot describe the island as it is now, and so must confine myself to a statement of what it was like in 1883. Its sides were steep, deeply furrowed, and even precipitous in places, and carried a good deal of scrubby vegetation besides some small but useful varieties of timber. At one place on the south-west side I observed a considerable deposit of guano, which, however, on analysis proved to be of very inferior quality. The island received its present name from the immortal Cook, probably on account of its emitting from its summit more or less dense clouds of white vapour. These clouds contained much free hydrochloric acid, and the atmosphere in the vicinity of the island was in consequence often anything but pleasant to the respiratory organs of those on board of passing vessels. When the barometer was high little or no vapour rose above the encircling crater wall so as to be visible from seaward, but when it was low the clouds often went right up into the air, and could then be seen from a long distance off, even before the island appeared above the horizon.

I landed at Crater Bay, on the south-west side of the island, which was the only place where there was a beach, and where there was a gap in the crater wall by which I could find easy access to the amphitheatre and

hot lake which occupied the interior. The beach consisted of large stones, and indeed boulders of trachytic lava, and extended a few chains from the sea. Beyond this point and within the crater the ground consisted of tufaceous cinter, superficially covered with gypsum. The inside of the crater had a most desolate appearance, as it was utterly destitute of vegetation. The wall was almost perpendicular all round, and of uneven height, being highest on its southern side. The early morning sun, shining through the feathery clouds of vapour which escaped from innumerable fissures all round the top of one side of the wall, produced a very pretty effect, giving the dull rocks the appearance of having an edging of bright silver. The floor upon which I stood occupied about two-thirds of the space within the amphitheatre, being about 40 acres in extent, and the lake—which stretched from side to side of the crater—covered an area of, I should think, 15 acres. On the opposite shore, and also at one end of the lake, active geysers could be seen throwing out steam and hydrochloric acid in great volumes. On our side of the amphitheatre there were no geysers, though the ground was in many places treacherous and perforated with holes, in the bottom of each of which there was a peculiar black acid mud in a violent state of ebullition. Here and there I noticed small fissures from which sulphuretted hydrogen and steam escaped very freely. At the base of the wall, and close to the margin of the lake, there were extensive accumulations of a mixture of gypsum and sulphur. Samples taken from different parts of these deposits were found to contain from 30 to 85 per cent of sulphur. While exploring this part of the amphitheatre I came upon numerous large balls of what at first sight appeared to be solid gypsum, but on breaking them with the aid of a stick they proved to be hollow shells, internally lined with projecting lemon-yellow prismatic crystals of sulphur, which quickly lost their transparency on exposure to the air! Some of these balls, or rather hollow spheres, were as large as old-fashioned bombshells. One or two which I measured had a diameter of 25 c.m. These mineralogical curiosities could not have been thrown from a distance, nor could they have been carried by water, but how they could have been formed *in situ* puzzles me to this day. The only facts I can offer concerning them are—(1) The shell-wall consisted of gypsum and a little sulphur. (2) The atmosphere within the sphere was much warmer than the outer air. (3) The shells did not occur near the lake or in proximity to active fumeroles. And (4) The sulphur found in them was invariably prismatic and transparent. Reason as I may, I can offer no theory to explain their formation.

It may be mentioned that the floor on this side of the lake reaches an elevation of nearly 60 feet above sea-level towards the interior between the lake and the sea, and then falls away to about 20 feet at the margin of the lake.

Before proceeding further it will perhaps be well to say a few words about Lake Hope,—a name given to this remarkable sheet of water by a previous explorer. It was first described by Dr. Roston and Lieut. Edwin, R.N , of H.M.S. *Brisk*, in 1868. These gentlemen state that it had a temperature of 43·3° C., and a uniform depth of 2 fathoms, at about 50 yards from the southern shore. It was then some 15 feet above sea-level. Hector, during his visit, also found the water to have a temperature of 43·3° C., but estimated the height above sea-level at 25 or 30 feet. I found the lake to register 68° C , and to be fairly uniform in depth, as stated by Roston and Edwin, but it was unfathomable near the centre. There could be no question, however, but that the appearance, temperature, and depth of the water were greatly influenced by meteorological and subterranean influences. I was informed by Judge J. A Wilson, of Touranga, an owner of the island and a man of service, that whenever there were unusual disturbances in the distant Hot Lake Country there were sure to be more or less remarkable changes in Lake Hope. Now, when we consider that there are at least 90 miles of land and sea between the places, this observation appears most interesting, and it is in some measure supported by the fact that a great part of the island disappeared during the terrible eruptions in the Lake Country. However, without further reference to this point, I shall return to my own experiences.

The lake, when I saw it, had a muddy appearance over its deepest part, but was blue-green and transparent elsewhere. The atmosphere over it was very irritating, owing to the hydrochloric acid, which came off from the water in abundance, and from the fumeroles near the margin. Two litres of the water were taken for analysis, and when the sample reached my laboratory in Melbourne it was perfectly clear, but had deposited small crystals of sulphate of calcium on the sides and bottoms of the bottles in which it had been put while warm. The crystals were re-dissolved in the water, and the following is the statement of the analysis in 1000 parts :—

Ferrous sulphate	15·254
Aluminium ,, ...	1·350
Calcium ,, ...	3·605
Magnesium ,, ...	0·931
Potassium ,, ...	4·715
Sodium ,, ...	10·033
Aluminium chloride	25·557
Sodium ,, ...	11·950
Silica	0·670
Hydrochloric acid	149·876
Water, &c.	776·059
	1000·000

This water has also been examined by Skey (*Trans. and Proc. N. Z. Instit.*, vol. iii., p. 278). It will be seen that free hydrochloric acid, chloride of aluminium, chloride of sodium, sulphate of calcium, and potash and soda alums are the principal constituents. The bottom of the lake, wherever visible, was thickly covered with oblique prisms of selenite. It may be mentioned that occasional bathing in Lake Hope had a very beneficial effect in some exceedingly bad cases of rheumatism.

The actual production of sulphur and hydrochloric acid in the fumeroles at one end and on the other side of the lake was one of the most beautiful sights I am ever likely to meet with in the whole laboratory of Nature. The fumerole at one extremity of the lake was rather small, but none the less deposited round its orifice bright yellow sulphur at the rate of about one hundredweight per week, and sent forth limitless volumes of hot hydrochloric acid and steam, which, as they ascended, often assumed the form of perfect vortex rings of great size. The hissing, rumbling, and grunting noises were almost deafening, and at irregular intervals there could be heard—" from far in the bowels of the earth "—peculiarly loud reports, as of explosions, which were immediately followed by the projection of large pieces of dark amber-coloured or red sulphur high into the air. The violence with which these projectiles were sent above the surface may be judged from the circumstance that I have seen pieces of sulphur weighing several pounds dashed against the rocks a hundred feet away from the fumerole.

On the side of the lake opposite to that on which I landed a new fumerole had sprung into existence within a few weeks of the time of my visit, and it had in the short time developed into the most extensive on the island. It was shaped like an inverted cone, had steep sides, consisting of a loose mixture of cinter, gypsum, and sulphur, made moist with acid-laden steam, and was about 40 feet deep. Its mouth had been raised about 6 or 7 feet above the surface of the ground, and had a diameter of perhaps 20 feet. The orifice of the fumerole from which the sulphur, steam, and hydrochloric acid came was circular, and did not occur exactly in the bottom of the cone, but rather to one side,—a peculiarity, by the way, of all the fumeroles on the island. Pieces of sulphur were shot to a height of 30 yards in the air.

One peculiarity of the sulphur ejected from the various

umeroles was its variation in colour. The material deposited at the orifices was for the most part pale yellow and opaque, but that which came out in lumps was quite transparent, and ranged from orange to reddish brown in colour. The tint generally became somewhat lighter as the lumps cooled. This darkness of colour I found to be due to selenium, which occurred in some specimens to the extent of 1·75 and 2·1 per cent. About 10 tons of White Island sulphur were sent to Melbourne, and used in vitriol-making, but it was found that the acid obtained from it had a very dirty appearance and deposited a large quantity of selenious matter on standing for a time. From that day the local manufacturers have refused to use the sulphur, preferring to import the Sicilian article.

Close to the fumeroles there were many large holes full of thin, black, boiling mud, which on examination I found to consist of clay, siliceous matter, gypsum, and iron pyrites, suspended in a strongly acid water containing even more mineral matter than the water of Lake Hope. The latter was fed by boiling-hot streams, which rushed down the courses and deep furrows worn in the steep floor of the crater.

The probability is that the sulphur and hydrochloric acid on the island result from the action of sea-water on hot beds of pyrites within the centre of the submerged mountain.

In concluding these notes I may say that the only indications of life on the island were a few rats, which certainly had shown a terrible want of wisdom in selecting such a home. I expect to hear, sooner or later, that the the remains of this "earthly hell" have sunk for ever into the fathomless sea.

ISOMERIC NAPHTHALENE DERIVATIVES.*

Addendum, December, 1887.†

In formulating the theory of the formation of azo dye-stuffs from beta-naphthol I have represented them as hydroxy-azo-compounds, the essential points to which I desired to call attention being the manner in which they were formed, and that the hydrogen atom in the α-position contiguous to the OH-group was displaced. But it is well known that Liebermann has pointed out, and indeed proved, that the beta-naphthol colours are not hydroxy-compounds, and that he has suggested that in their production a change takes place analogous to that which results in the formation of iso-nitroso-compounds, the formula which he has proposed containing the closed chain—

$$\left.\begin{matrix} C.NH \\ C.O \end{matrix}\right\} NX$$

There can be no doubt that Liebermann's contention is, in the main, correct, but the exact form of the subsidiary closed chain and the position of the hydrogen relatively to the nitrogen is not yet established; and it is even conceivable that the dye-stuffs in question are not closed chain compounds, as represented, but that they contain a dyad radicle N.NHX and CO; that they are hemi-quinones in fact. It is noteworthy that the alpha-naphthol colours do exhibit acidic functions, and Liebermann therefore considers that they are hydroxy-compounds, but it is conceivable that hydrogen attached to nitrogen may exercise acidic functions in their case. The further elucidation of these points by the comparative study of naphthol and naphthylamine colouring-matters will be of importance on account of their bearing on the manner in which the colours are formed, and especially on account of their bearing on the constitution of azo colouring-matters generally.

* Second Report of the Committee, consisting of Professors Tilden and Armstrong (Secretary), appointed for the purpose of investigating Isomeric Naphthalene Derivatives. (Drawn up by Professor Armstrong). Presented to the British Association, Manchester Meeting, 1887.

† The Report was inserted in our last issue (Chemical News, vol. lvi., p. 241).

ACTION OF SULPHURETTED HYDROGEN ON SALTS OF COBALT.

By H. BAUBIGNY.

The author shows that the action of small quantities of acetic acid modifies the action of sulphuretted hydrogen upon cobalt sulphate less profoundly than upon nickel sulphate; but if, instead of acetic acid we add sulphuric acid or any of the strong acids, this difference tends to disappear. For both metals no reaction is produced, even after several days at the ordinary temperature, if the weight of free sulphuric acid is the half of that contained in the salt. Still we must operate with solutions containing at least 0·150 grm. of sulphate per litre, for if the proportion of the salt becomes sensibly inferior to that indicated the acidity becomes almost unimportant, and the sulphuretted hydrogen recovers a part of its chemical activity, especially in the case of cobalt, the solution of which is blackened much more rapidly than that of nickel.

We are here, of course, speaking of initial conditions, for in the action of hydrogen sulphide upon a solution of sulphate, neutral to begin with, the acidity goes on augmenting with the duration of the experiment, both with cobalt and nickel, since the quantity of acid set at liberty increases with the weight of the sulphide formed.

After the lapse of ten days only 12 m.grms. of cobalt sulphate remained in the liquid of the 400 originally employed. The cobalt sulphide intervenes in the reaction, as it is the case with nickel. If in this experiment we remove, after the expiry of a certain time, the sulphide already formed, the reaction stops. This is natural, because in reality we have then the initial conditions of an acid solution of sulphate just as inversely the transformation of cobalt sulphate into sulphide commences and continues progessively if we add to a solution of this sulphate saturated with hydrogen sulphide and acidified with an excess of sulphuric acid, a quantity of the sulphide of metal approximately equivalent to the free sulphuric acid present.

For both cobalt and nickel the conversion of the sulphate into sulphide is the more rapid as the tension of the dissolved hydrogen sulphide is greater, whence it is probable that a rise of temperature should produce the same action on a sulphuretted solution of cobalt as on one of nickel.

In fact a solution of 0·2 grm. of cobalt sulphate in 140 c.c. of water, saturated at 0° with sulphuretted hydrogen, will retain only 0·003 grm. of sulphate after standing for six hours in a closed vessel at 100°. The action is, therefore, very sharply definite. Still, if we compare the results with those obtained with nickel, it is easy to see that the transformation is less perfect in the former case than in the latter. This fact is confirmed by special comparative experiments. Of two solutions, the one of cobalt and the other of nickel, each containing 0·410 grm. of neutral sulphate in 410 c.c. of water saturated at 0° with hydrogen sulphide, and heated in closed vessels, the second alone (nickel) is completely converted into sulphide after standing for six hours at 100°. On connecting this fact with the observation that a solution of neutral nickel sulphate saturated with hydrogen sulphide gives, in the cold, more sulphide after some days than an identical solution of cobalt sulphate under the same conditions, it seems that the cobalt salts are more easily converted into sulphide than those of nickel when the solution is neutral and very slightly acid, whilst an inverse action is perceived when the acidity augments.

If this is the case the differences between the weights of the nickel and cobalt sulphides formed ought to be the more marked on working with solutions of neutral salts richer than those employed already, for the acidity will be proportional to the quantity of sulphate decomposed. Moreover, in one and the same medium the limit of precipitation is reached more rapidly in heat than at the ordinary temperature. Two solutions of cobalt and

nickel sulphates, each containing 1·2 grm. of the salt in 140 c.c. were heated for three hours to 100° in closed vessels after being saturated with hydrogen sulphide at 0°. After this time the mother-liquor from the cobalt still retained 0·041 grm. of sulphate, whilst that of nickel retained only 0·006 grm. of soluble matter. The difference is further intensified if we operate in a medium which has previously been slightly acidulated with sulphuric acid.

The natural consequence of this fact is that to prevent entirely the formation of cobalt sulphide at 100° a quantity of free acid is required relatively smaller than is needed to prevent the decomposition of nickel sulphate, all other conditions being identical in both cases. Whilst 0·4 grm. nickel sulphide, dissolved in 140 c.c. of water saturated at 0° with hydrogen sulphide, and containing 0·515 grm. of free sulphuric acid (*i.e.*, two and a half times the weight of the acid present in the salt) gives, after standing for eight hours in a closed vessel at 100°, a quantity of sulphide corresponding to 0·218 grm. of sulphate, the precipitation of sulphide in an identical solution of cobalt is almost nul.

As for a concentration varying between the limits of 2 to 8 grms. sulphate per litre, a solution of nickel must be mixed with a weight of free sulphuric acid, equal to about five times the acid present in the salt dissolved if it is not to be precipitable by sulphuretted hydrogen at 100°, we see that the limit of the reaction at 100° between the sulphates of the two metals and sulphuretted hydrogen in presence of an excess of sulphuric acid corresponds in nickel to a relatively greater acidity than in cobalt.

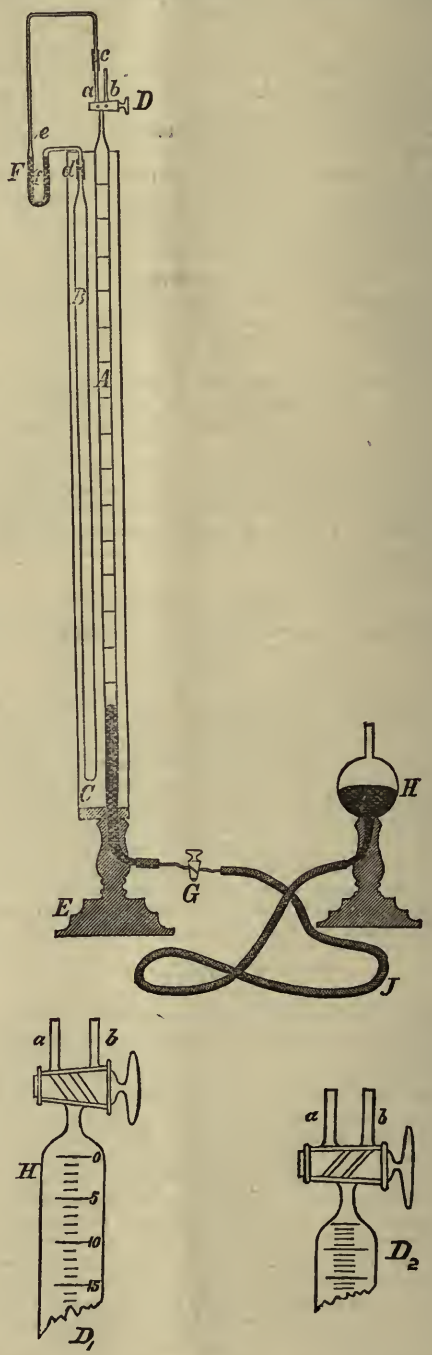
Therefore, if the laws of the conversion of sulphates into sulphides by the action of hydrogen sulphide are the same for cobalt and nickel, at least, generally speaking, cobalt becomes sulphuretted more rapidly than nickel in a neutral or very slightly acid liquid, and when the relative acidity of the liquid increases the progress of the reaction changes; in an acid liquor the nickel sulphate is most readily transformed, though on condition that such acidity is not present at the outset, when it puts a stop to all reaction.

This difference is so decided that we recognise it even in presence of feeble acids. Thus a solution of neutral sulphate of cobalt containing only small quantities of acetic acid, is more rapidly acted upon in the cold, all other things being identical, than a similar solution of nickel. On the contrary, if the proportion of acetic acid contained in the liquid is increased (in which case the action of heat is necessary) the nickel is always the more readily precipitated.—*Comptes Rendus*, cv., p. 806).

W. HEMPEL'S GAS-BURETTE.

This instrument has the advantage of being unaffected by the fluctuating pressure and temperature of the atmosphere. This is effected by connecting the apparatus with a space free from air, but saturated with aqueous vapour. In Fig. 1 is shown such a gas-burette with correction for temperature and pressure. A is an ordinary gas-burette graduated into 100 c.c., and fixed in a heavy cast-iron foot, E. The burette is closed at top by a Greiner-Friedrich glass cock, opening into two capillary tubes, *a* and *b*. By means of two short pieces of caoutchouc tubes the burette is connected with the manometer, F, and the correction tube, B. This correction tube is a simple glass tube melted up at the bottom, and communicating with the manometer, F, by a caoutchouc tube. The burette and the correction tube are enclosed in a wide glass casing tube, C, filled with water. The tube C is open above and closed below by a caoutchouc plug with one perforation. The manometer tube F is about 6 m.m. wide in its U position, but from *e* to *c* it is capillary if mercury is used as the closing fluid, but if water is employed this part is 3 m.m. in width. The burette is connected by caoutchouc tubes with the cock G and the level-ball H.

As a closing fluid there may be used either mercury or water saturated with the gases to be examined. If the



gases are measured moist, which is generally preferable, a drop of water is placed in the correction tube B.

Before putting the apparatus in use it is necessary to ascertain, once for all, the size of the space between *f* and *e* in the manometer tube. This is effected by drawing

any volume of gas into the burette and bringing the three-way cock to the position D, so that the burette communicates with the manometer; by raising or lowering the level-ball the enclosed gas can be readily brought to the same pressure as the gas in the correction tube B. This is the case when the liquid stands at the same height in both limbs of the U-shaped part of the manometer tube, F. The cock G is closed, and the volume of the gas is read off on the scale.

If we then open G again, and lower the level-ball H, the liquid in the manometer tube can easily be drawn up to *c*. If the cock D is then again closed, and the volume of the gas read off on the scale (after previously bringing the gas to the pressure of the atmosphere by raising the level-ball), the difference of the two readings shows the volume of gas sought, between *f* and *e* in the manometer tube. It is here assumed that the volume of air inclosed in B has the external pressure then prevailing which can be easily attained, as otherwise we only need to draw the manometer tube at *d* out of the caoutchouc tube in order to equalise any difference of pressure.

When this constant has been determined we proceed as follows in gas measurements:—We first fill the burette entirely with the closing fluid by raising the level-ball. We then connect the instrument by a capillary tube with the receiver containing the gas in question, and draw the latter in. The three-ways cock must thereby have the position D_2, so that the gas may enter the tube *b*. For measuring, the cock is brought into the position D_1. Then the liquid is brought to the same height in both limbs of the U-shaped part of the manometer tube by raising or lowering the level-ball, and the volume of gas is read off. The true volume of the gas = the reading + the correction. After measuring, the gas is drawn back from the manometer tube into the burette. The absorptions are effected in gas-pipettes, connected with the tube *b* by means of capillary tubes.

The obliquely bored Greiner-Friedrich glass cocks have the great advantage that imperfect closing, in consequence of the formation of grooves, is here quite impossible.

Messrs. Townson and Mercer, of Bishopsgate Street, are the agents in this country for Messrs. Greiner and Friedrich.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 1st, 1887.

Mr. WILLIAM CROOKES, F.R.S., President, in the Chair.

MR. HENRY DROOP RICHMOND was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Edward Arthur Andrews, 52, Camden Road, N.W.; Albert Wodehouse Day, Lancing College; Philip Anderson Estcourt, Vyrniew House, Talbot Road, Old Trafford, Manchester; William Gay Forsyth, 2, Granville Place, Glasgow; John Booth Kirkland, Prince's Hill, Carlton, Melbourne; Thomas Atkinson Lawson, Ph.D., B.Sc., 15, Alexandra Road, N.W.; Frederick William Shaw, Heapey Bleach Works, North Chorley.

The following were elected Fellows of the Society:—Messrs. Frank Calder, Horace Woodward Crowther, T. Arthur Dickson, Charles A. Fawsitt, David R. S. Galbraith, Joseph C. A. Hall, James G. Heywood, Cassimir J. Head, Walter Hogbin, Samuel Lees, Jun., David Lennox, Eberhard Luttgen, John McArthur, Angus Mackay, Sydney Martineau, William E. Matthews, John A. Miller, B.Sc., John C. H. Mingaye, Archibald R. Ormiston, Julius Ostersetzer, Andrew W. Taylor, Jose Maria Vargas, John Septibo Ward, Bartlett W. Winder.

The following papers were read:—

86. "*The Alleged Existence of a Second Nitroethane.*" By W. R. DUNSTAN and T. S. DYMOND.

The authors have repeated the experiments of Kissel (*Jour. Russ. Phys. Chem. Soc.*, 1882, 226—230; and 1884, 135—140), who alleges that when the interaction of ethyl iodide and dry silver nitrite takes place at 0°, no ethyl nitrite is formed, but nitroethane together with a new isomeride (b. p. 29—30°), which though possessing certain of the properties of ethyl nitrite, appears to be more closely allied to nitroethane. The authors were unable to isolate any such substance. They show that by carefully fractionating the liquid obtained from the interaction at 0° of ethyl iodide and dry silver nitrite, it may ultimately be resolved into ethyl nitrite and nitroethane, and further, that fractions which distil at low temperatures (below 100°) exhibit the chemical properties of a solution of ethyl nitrite in nitroethane.

87. "*An extension of Mendeléeff's Theory of Solution to the Discussion of the Electrical Conductivity of Aqueous Solutions.*" By HOLLAND CROMPTON.

The method made use of by Mendeléeff in his paper on "The Compounds of Ethyl Alcohol with Water" (*Chem Soc. Trans.*, 1887, 778), to which the dependence of change of relative density on percentage composition was considered, has been applied by the author, at Dr. Armstrong's suggestion, to the discussion of the electrical conductivity of aqueous solutions, the determinations given by F. and W. Kohlrausch being made use of for the purpose.

The curve obtained in the case of sulphuric acid, representing change of conductivity, with percentage composition $\frac{dk}{dp}$ as depending on the conductivity, was not found to give evidence of the presence of any hydrates in solution. A second differentiation was therefore resorted to and the coefficient $\frac{d^2k}{dp^2}$ plotted out for different percentage compositions. The curve thus obtained has an undoubted rectilinear character and is discontinuous, having breaks at points corresponding to hydrates of the composition $H_2SO_4 \cdot OH_2$, $H_2SO_4 \cdot 2OH_2$, $H_2SO_4 \cdot 6OH_2$, $H_2SO_4 \cdot 24OH_2$, and $H_2SO_4 \cdot 150OH_2$. The presence of all these hydrates, with the exception of that with 24 molecules of water, in aqueous solutions of sulphuric acid has already been recognised by Mendeléeff, who deduced their existence by discussing the change in density of such solutions by the same method that he employed in the case of ethyl alcohol. It is concluded from this that the electrical conductivity of sulphuric acid solutions cannot be a continuous function of the percentage composition, but that it is influenced by certain hydrates existing in the solution, indication of the presence of which is afforded by the second differential coefficient curve.

A certain irregularity exists at each end of the second differential coefficient curve, where the pure compound may be said to first undergo dilution. This is regarded as representing an initiative stage during which the action of the compounds just beginning to be formed has not come fully into play, and the conductivity is influenced by a number of physical actions here probably taking place. It is also pointed out that no break occurs on the second differential coefficient curve corresponding with the maxima observed on the conductivity curve, as the maxima are found to occur at points intermediate between the breaks on the second differential curve. The influence of both hydrates present on the conductivity seems to determine the maximum, which probably represents that the sum of the influence of each is here greatest.

Further confirmation of these facts is obtained by the discussion of other solutions, all of which are found to act in a manner similar to sulphuric acid. In the case of nitric acid there is evidence of the formation of two hydrates, $HNO_3 \cdot 15OH_2$ and $HNO_3 \cdot 4OH_2$; and in that of

phosphoric acid of the two hydrates $H_3PO_4 \cdot 8OH_2$ and $H_3PO_4 \cdot 2OH_2$, the presence of the same hydrates being also indicated in each case by Mendeléeff's curve for change of density. In the case of potassium and sodium hydroxides, the hydrates appear to be the same, namely, one with 10, and one with 6 molecules of water.

The fact that the second differential coefficient is a rectilinear function is regarded as evidence that the conductivity is a function of the third order of the percentage composition, $K = A + Bp + Cp^2 + Dp^3$, this function, however, being only continuous between the limits indicated.

88. "*Note on Electrolytic Conduction and on Evidence of a Change in the Constitution of Water.*" By Henry E. Armstrong.

In this addendum to the foregoing paper, the author claims the results in support of the hypothesis which he has elsewhere advocated, that electrolysis is not a mere dissociation phenomenon but depends on an influence which one set of molycules exerts on another set while both are under the influence of the electromotive force. Discussing the first differential coefficient curve, he points out that the influence is exerted almost entirely at two points: in the interval between the acid and the hydrates $H_2SO_4 \cdot OH_2$ and $H_2SO_4 \cdot 2OH_2$; and especially in the interval between the two hydrates $H_2SO_4 \cdot 6OH_2$ and $H_2SO_4 \cdot 24OH_2$. It is suggested that the comparative smallness of the effect in the former case is due to the acid being present in a "polymerised" less active state, and that the lower hydrates are perhaps also derivatives of a polymer of H_2SO_4. Indication is afforded by a break in the curve of the existence of a compound $2H_2SO_4 \cdot SO_3$. The author is informed by Dr. Messel that on mixing the anhydride and acid, crystallisation first takes place when the mixture has about the composition of such a compound, thus confirming its existence. It is suggested that peculiar breaks in the curve when a small percentage of acid is present with the water, or *vice versâ*, are evidence of a change in the molecular composition of the fluids. Lastly, it is suggested that the electrolysis of fused salts may be supposed to take place in the same way as that of solutions, *i.e.*, that they contain molecules of different orders of complexity capable of influencing each other, and that it is no longer necessary to suppose that there is any fundamental difference in the mode in which the two classes of electrolytes are affected.

Discussion.

The President remarked that the results obtained by Mendeléeff, and now by Mr. Crompton, illustrated the necessity of caution in drawing conclusions from curves which directly represented the results of observation.

Mr. Pickering characterised Mendeléeff's recent communications on density curves as containing a discovery of the highest importance. The acceptance of the hypothesis involved in his conclusions must depend on whether the breaks shown by the differential curves occurred at points exactly corresponding to hydrates of definite composition, and whether different physical properties of the same solution all exhibited breaks at the same points. Mr. Crompton's investigation afforded the first evidence that this latter confirmation was forthcoming. For some months past Mr. Pickering had been examining the curves representing the densities, specific heats, and heat of dilution of salt solutions, and he felt confident that the results would confirm Mendeléeff's views and afford conclusive proof as to the chemical nature of dissolution. He intended also to further examine the heat of dilution of sulphuric acid, and from the heat of dilution he hoped to obtain more definite results than from the study of densities. As far as his present results went, he had obtained evidence in two or three cases of breaks at about $150H_2O$, as well as breaks at a much higher state of dilution. He did not, however, believe in the existence of compounds such as cryohydrates were assumed to be, and thought that such breaks might well be explained, as Dr. Armstrong suggested, on the view that water and liquids in general were made up of molecular aggregates.

Dr. Morley agreed with Professor Pickering that it was much better to make the curves tell their own story in the manner indicated by Mr. Crompton and Dr. Armstrong, than to divide them by the eye into arbitrary sections in the way which had hitherto been usual. He anticipated that the new method would lead to important results. At the same time he did not quite see at what point differentiation should stop: Mendeléeff had differentiated his curves once, Mr. Crompton had performed the operation a second time—why should it not be executed a third or a fourth time? It was obvious that the position of the maxima and minima was greatly changed after each differentiation, and therefore the system of straight lines which most nearly approximated to the curve would be different in each case.

No doubt, if at any time the curve should exactly resolve itself into straight lines, that would be a proper time to stop, but, if only on account of experimental errors, it was not likely that this would often happen. If we knew the law that governed the change of conductivity of a solution whose molecular constitution was not altered by dilution, the problem would be solved; thus if the curve expressing that law were a conic section we should differentiate once, if it be a cubic we must differentiate twice, and so on. For example, the same experimental curve might perhaps be represented, within the limits of experimental error, either by portions of five conic sections, by portions of three cubics, or by parts of two curves of the fourth degree; which representation was to be chosen?

Prof. Ramsay agreed with Dr. Morley's remarks. He asked Mr. Crompton whether any physical meaning was to be attached to the second differential coefficient, or if it was merely found to fit the facts. Commenting on Dr. Armstrong's remarks, he asked to be informed what special views on electrolysis were held by Dr. Armstrong which could be supported by the proof of the existence of complex molecular aggregates. Dr. Armstrong had spoken of such molecular aggregates being urged past each other by the electric current; but of this there would appear to be no proof, for, as far as the speaker knew, there was no proof of the separation of such aggregates to opposite poles during the passage of a current. Moreover, granting Dr. Armstrong's assertion that such transference of molecular aggregates in opposite directions did occur, how is the fact of electrolysis to be explained by the friction of those travelling in opposite directions? Did Dr. Armstrong imagine that the corners of such aggregates were rubbed off?

Mr. Crompton, replying to Dr. Morley's objection that there did not seem to be any reason why a limit should be put to the differentiation when that operation had been performed twice, and that it would be just as reasonable to proceed with a third or fourth differentiation, and so on, said that a limit to the differentiation would necessarily have to be made according to the nature of the case under investigation and the discretion exercised by the investigator. In the present instance the limit of differentiation is clearly indicated by the agreement of the results obtained with those previously arrived at by Mendeléeff by discussing a totally different physical property. There would obviously be nothing gained by a further differentiation in the present case, for, supposing that operation to be again performed, it would give first a constant, and on repetition zero, or at most leave the errors due to experiment, and those which come in when performing the differentiation. In general it is easy to recognise when this stage is reached, provided that the errors are small, as in the experiments under discussion. In reply to Prof. Ramsay he said that he could not give any physical meaning to the second differential coeffic ent.

Dr. Armstrong said that he could not now usefully reply to the questions put by Prof. Ramsay, as to do so

would involve a lengthy explanation of all that had previously been urged; moreover, his views had been fully stated in documents which were in the hands of the members of the British Association Electrolysis Committee.

89. "*Bismuth Iodide and Bismuth Fluoride.*" By B. S. Gott and M. M. Pattison Muir.

The preparation of bismuth iodide in the wet way, by addition of potassium iodide to a solution of bismuth nitrate, is described. The amounts of decomposition of specimens of bismuth iodide prepared in the wet and dry ways by heating with water are tabulated, and shown to be practically the same.

The preparation of bismuth fluoride by adding potassium fluoride solution to a solution of bismuth nitrate is described, and the properties of this salt are enumerated.

The relative densities of BiI_3, BiF_3, and BiOF are given.

90. "*The Action of Hydrogen Sulphide on Arsenic Acid.*" By B. Brauner, Ph.D., and F. Tomicek.

When arsenic acid is treated with hydrogen sulphide, the precipitate consists either of arsenic pentasulphide or contains in addition arsenic trisulphide and sulphur. The authors find—(1) that when a *rapid* current of hydrogen sulphide is passed into a warm solution of arsenic acid containing chlorhydric acid, the pentasulphide is formed slowly, but completely:—

$$2H_3AsO_4 + 5H_2S = As_2S_5 + 8H_2O;$$

(2) that in solutions of the acid, or when the gas is passed *slowly* into warm solutions of arsenates containing chlorhydric acid, a secondary reaction takes place together with the first chief reaction, but never alone, viz.—

(*a*) $H_3AsO_4 + H_2S = H_3AsO_3 + S + H_2O$;
(*b*) $2H_3AsO_3 + 3H_2S = As_2S_3 + 6H_2O$.

91. "*Note on the Constitution of Mairogallol.*" By C. S. S. Webster.

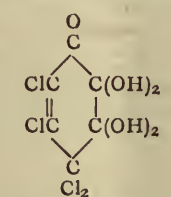
On chlorinating the trihydric phenols pyrogallol and phloroglucinol, I succeeded in obtaining from both the trichloro-derivative (*Chem. Soc. Trans.*, 1886, 423), this stage of the chlorination having previously been overlooked in both cases. Identical results have since been published, without the slightest reference to my work, by K. Hazura and Benedikt (*Chem. Soc. Abstr.*, 1886, 52), and by A. Hantzsch and K. Schniter (*Ber.*, xx., 2033—2040).

The continued action of the halogen operates very differently on the two trichloro-derivatives; in the case of phloroglucinol the benzene nucleus is broken down and chloracetic acids are formed; in the case of pyrogallol there is a union of the C_6 nuclei with formation of C_{18} derivatives, though, from the empirical composition of these it can scarcely be doubted that the double union of the carbon-atoms is resolved at several points. Since the publication of my last note I had been engaged in investigations into the constitution of mairo-gallol and leucogallol, the C_{18} derivatives in question, the results of which have now to a certain extent been anticipated by Hantzsch and Schniter. Their discussion of the constitution of these compounds is based upon one observation only, viz., that they yield trichloropyrogallol as the chief product on reduction by zinc and sulphuric acid. From this and the numerical ratios of the empirical formulæ they arrive at a constitutional formula representing them as a species of quinone chlorides.

The decompositions, which I had studied with the object of elucidating their constitution, are those by water, by heating alone, and by the action of the hyposulphites. On boiling mairogallol with water a rapid decomposition sets in, carbonic anhydride is liberated, and the residual products in solution are oxalic acid and trichloropyrogallol. If sulphurous acid be introduced during the heating a similar decomposition ensues; but the solution contains, in addition to the above-named products, a condensed derivative, which is precipitated from solution by gelatin. On treating mairogallol with sodium hydrogen sulphite in aqueous solution, and adding zinc dust, reduction ensues; the chief product is again trichloropyrogallol. In addition to this amorphous substances are obtained, which may be separated by precipitation with lead acetate and subsequently purified: these resemble the lignocelluloses in giving furfural on distillation with dilute sulphuric acid, and yellow-coloured substitution-derivatives with chlorine, characterised by the magenta reaction with sodium sulphite. On gradually heating mairogallol a sublimate of trichloroquinone and tetrachloroquinone is obtained. The residue is a mixture of a number of products, some of which were isolated in the crystalline form, but in quantity too minute for investigation. Some are amorphous, and precipitated by gelatin from aqueous solution.

Leucogallol when heated at 100° is easily converted into trichloropyrogallol and a product reacting like quinone. Following up the indications of these results, I endeavoured to obtain synthetical products from quinone (chloroquinones) and trichloropyrogallol, but I could obtain no products of combination.

These results undoubtedly confirm the view of Hantzsch and Schniter, that the compounds in question are derived by condensation from a hypothetical molecule represented by the formula—



a substituted quinone in which one of the characteristic oxygens is displaced by Cl_2 and the aromatic linking of the carbon atoms in part resolved.

It is well, however, to bear in mind that this view is based rather upon inferences from the empirical formula than upon actual proof; and it is at least probable that one or more of the C_6 nuclei are more completely resolved, in respect of aromatic constitution, than has been assumed.

With the view of further elucidating the matter, I was engaged at the time of the publication of the paper in question, and still am, in studying these decompositions quantitatively.

In the course of this investigation I had occasion to recrystallise mairogallol from chloroform. Two specimens obtained in this way, after drying at 100°, gave on analysis 52·41 and 52·47 Cl per cent respectively, whereas a specimen re-crystallised from benzene gave 30·34 per cent Cl (calc. $C_{18}H_7Cl_{11}O_{19} = 50·4$ per cent Cl); (calc. $C_{18}H_7Cl_{11}O_{10} : CHCl_3 = 52·37$ per cent Cl). The chloroform appears, therefore, to be retained in molecular combination.

PHYSICAL SOCIETY.

December 10th, 1887.

Prof. W. E. Ayrton, F.R.S., Vice-President, in the Chair.

Mr. E. A. C. Wilson and Mr. W. E. Sumpner, B.Sc. were elected members of the Society.

Mr. H. G. Madan described the "*Optical Properties o Phenyl-thio-carbimide.*"

This body, derived from aniline, is a colourless liquid, density 1·35, and of high boiling-point, 222° C. The refractive indices for the A and G lines are 1·639 and 1·707 respectively. It is thus seen to be a highly refractive liquid, and to have about the same dispersive power as carbon bisulphide, whilst its use in prisms is unattended by many of the risks and inconveniences experienced with

carbon bisulphide. The dispersion at the blue end of the spectrum is very marked. Being less mobile than carbon bisulphide it is less affected by convection currents. The "refractive equivalent" calculated from its chemical constitution differs considerably from the observed value, and this difference the author believes due to the presence of the phenyl radicle and sulphur atom. A polarising prism had been made on Jamin's plan, but using phenyl-thio-carbimide, as the liquid gives a fairly wide angular field (about 25°).

Mr. HILGER stated that there was no great need of liquid prisms now, for very dense flint-glass could be obtained with mean index of about 1·8. Dr. Perkin has recently supplied him with Canada balsam perfectly colourless, and which does not tarnish the polished faces of spar; hence one of the greatest objections to the use of Canada balsam in spar polarising prisms has been removed.

Dr. GLADSTONE pointed out that the constants for the phenyl radicle and for sulphur atoms had been determined, and thought the calculated "refractive equivalent" obtained by including these would be much nearer the observed value than the one given by Mr. Madan.

"*On the Recalescence of Iron.*" By Mr. H. TOMLINSON.

If an iron bar which has suffered permanent strain be heated to a white heat and allowed to cool, the brightness at first diminishes and then reglows (recalesces) for a short interval. Under favourable circumstances as many as seven reglows have been observed during one cooling. Generally two decided ones are observed, one between 500° and 1000° C., and the other below 500° C. The effects the author believes due to "retentiveness" of the material, somewhat similar to the causes of residual magnetism and residual charge of a Leyden jar.

A table of experimental results, giving the torsional elasticity and internal friction at different temperatures, for iron wire, showed sudden increases in internal friction at temperatures of about 550° and 1000° C. The table also shows that the torsional elasticity slowly decreases as the temperature increases, whereas the internal friction increases enormously. This explains why bells cease to emit musical notes when heated.

The author finds that the recalescence at the higher temperature is not appreciably accelerated by mechanical vibration, such as hammering, &c., but those occurring at lower temperatures are greatly influenced by such treatment and by magnetic disturbances.

Prof. FORBES believed the explanation of recalescence given by himself about 1873 is sufficient to account for the effects observed. This explanation postulates a sudden increase in thermal conductivity about the temperature at which recalescence occurs, which permits the heat from the inside to reach the outside more readily, and thus raise the temperature of the surface. The subsequent reglows observed by Mr. Tomlinson he believes due to convection currents of air.

Prof. RÜCKER suggested that calorimetric experiments might determine which view was the true one; and Prof. AYRTON thought the question might be decided by having two half-round bars, nearly in contact at their flat sides, heated up and allowed to cool, and noting whether any sudden change in the bending of each bar (due to unequal temperatures at the inner sides and outer sides) took place about the critical temperatures.

"*On the Rotation of a Copper Sphere and of Copper-Helices when freely suspended in a Magnetic Field.*" By Dr. R. C. SHETTLE.

The author exhibited the apparatus with which his experiments "On the Supposed New Force" were made, the results of which were published in *The Electrician* (vol. xix.). Dr. Hofford has recently made similar experiments, using brass discs, and his results seem to point to "diamagnetic non-uniformity" of the discs as the cause of the phenomena he observed.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, December 5, 1887.

WARREN DE LA RUE, Esq., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

THE following were elected Members:—Victor Horsley F.R.S., F.R.C.S.; Mrs. Victor Horsley; George Lindsay Johnson, M.B., M.A., F.R.C.S.

The following Lecture Arrangements were announced:—

Sir Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland.—Six Lectures (adapted to a Juvenile Auditory) on "Astronomy: The Sun, Moon, Planets, Comets, and Stars." On Dec. 27 (Tuesday), Dec. 29, 31, 1887; Jan. 3, 5, 7, 1888.

George John Romanes, M.A., LL.D., F.R.S.—Ten Lectures, "Before and After Darwin." On Tuesdays, Jan 17 to March 20.

Hubert Herkomer, M.A., A.R.A., Slade Professor of Fine Art in the University of Oxford. Three Lectures on Thursdays, Jan. 19, "The Walker School; Jan. 26, "My Visits to America;" Feb. 2, "Art Education."

C. Hubert H. Parry, M.A., Professor of Musical History and Composition at the Royal College of Music.—Four Lectures on "Early Secular Choral Music," from the Thirteenth Century till the beginning of the Seventeenth. (With Illustrations.) On Thursdays, Feb. 9, 16, 23, March 1.

The Rev. W. H. Dallinger, LL.D., F.R.S.—Three Lectures on "Microscopical Work with recent Lenses on the least and simplest Forms of Life." On Thursdays, March 8, 15, 22.

The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S. Seven Lectures on "Experimental Optics" (Illustrated by Electric Light). On Saturdays, Jan. 21 to March 3.

William Archer, Esq. Three Lectures on "The Modern Drama: French, Scandinavian, and English." On Saturdays, March 10, 17, 24.

OBITUARY.

THE LATE AUGUST STROMEYER.

WE have to notice the sudden death of August Stromeyer, which took place on November 21st, whilst he was engaged in a weighing operation in his laboratory.

From the *Chemiker Zeitung* we learn that the deceased was born at Limmer, near Hanover, July 7th, 1807. He entered the University of Göttingen in 1825 with the intention of studying law, but at the end of the first term he turned his attention to the natural sciences, and especially to chemistry. In 1828 he went to Paris to continue his studies under Gay-Lussac, Thenard, and Dumas. In 1832 he removed to London, and subsequently held the position of assistant to Prof. Clarke at Aberdeen. In 1834 he became manager of a manufactory of chrome products in Norway, where he developed the conversion of the chrome-iron of Röraas into chromium disulphate. In 1852 he left Norway on account of his health, and returned to Hanover, where he spent the rest of his life in chemical research, especially of a technical character. His most important investigation are to be found in *Liebig's Annalen*, though a number of brief communications appeared in the *Zeitschrift des Gewerbe-Vereins für Hanover*, and in the *Wochenblatt für Handel und Gewerbe.*

The Anilides of the Glucoses.—M. Wassily-Sorokine.—The author has succeeded in preparing the crystalline anilides of galactose, levulose, and dextrose.—*Moniteur Scientifique*, Sept., 1887.

NOTICES OF BOOKS.

The Saliva as a Test for Functional Disorders of the Liver. By SAMUEL FENWICK, M.D. London: J. and A. Churchill.

IT is well known that the human saliva contains potassium sulphocyanide. The proportion of this salt is, according to the author's observations, very variable, and these variations correspond so closely with changes in the action of the digestive organs that a quantitative examination of the saliva may furnish the physician with valuable indications. The method of determination adopted is colorimetric. As a standard a solution of iron sulphocyanide of definite strength is prepared, and is graduated by successive dilutions so that each solution is exactly three-quarters of the strength of the one preceding. These standard solutions are then placed in a series of small flat bottles, like those used for spectroscopic purposes. Each specimen of saliva examined is first mixed with a definite quantity of the tincture of ferric chloride, filtered through cotton-wool, placed in a bottle of equal size and thickness, and compared with the graduated standards. A preliminary trial showed that in healthy persons the colour produced varied considerably, though in the majority a normal point was recognised. Observations were then made on the patients of the London Hospital.

The observations here made have chiefly a medical interest, but we may note, as the best-established result of this interesting inquiry, that the quantity of sulphocyanide was below the normal "whenever the digestive organs are unable to supply nutriment sufficient to meet the requirements of the system."

Experimental Chemistry for Junior Students. By J. EMERSON REYNOLDS, M.D., F.R.S., F.C.S. Part IV. Chemistry and Carbon Compounds, or Organic Chemistry (with an Appendix on Ultimate Organic Analysis). London: Longmans, Green, and Co.

IT is difficult to form a fair estimate of any work without having the opportunity of examining it as a whole. Dr. Reynolds, in the part before us, seeks "to harmonise the natural with the systematic study of carbon compounds." He considers that "the best corrective of hard mechanical conceptions of molecular structure is the chemical changes that can be induced by variations of experimental conditions." In twenty-two chapters he takes the student through the totality of classes of compounds from wood spirit to the alkaloids.

To survey all these groups of substances within the compass of 380 small pages requires great condensation. Accordingly the utmost concision in style has been aimed at. We find that the author does not, like many authorities, place theobromine and caffeine among the alkaloids, but refers them to the derivatives of urea. The space given to the aniline colours is small when compared with that devoted to artificial indigo, which, interesting enough as a laboratory experiment, would have had certain very unpleasant results if it had proved a commercial success. The author also notices favourably the search for substitutes for quinine. The author considers the ordinary methylated spirit "useless for drinking." So it was intended to be, but unfortunately workmen in establishments where it is used often drink it, even when it contains the further addition of shellac. The circumstance that the wood-spirit added to the ethylic alcohol must be impure renders this spirit much less of a boon to chemical manufacturers than it is commonly supposed. The German Government now allows spirit for industrial purposes to have an addition of only 3 per cent of a mixture of two parts wood-spirit and one part of pyridine bases.

The work before us is a good summary of organic chemistry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 18, October 31, 1887.

New Fluorescences with well-defined Spectral Rays.— Lecoq de Boisbaudran.—Gallium oxide, strongly ignited, gives fluorescences generally less bright than those due to alumina, but the results are of the same order. Gallia containing 2 per cent of samaria gives a fine fluorescence, much less intense and more red than that of alumina and samaria. The fluorescent rays of alumina charged with praseodymium gain in lustre when the action of the induced current is prolonged.

Researches on the Application of the Rotatory Power to the Study of Compounds formed by the Action of Ammonium Molybdate upon Solutions of Tartaric Acid.—D. Gernez.—In experiments on the action of tartaric acid upon sodium and ammonium molybdates, the compounds corresponding to the maximum rotation contain, in case of the former salt, 1 equivalent, and in the second only $\frac{1}{2}$ equivalent, but this discrepancy disappears if we consider that ammonium molybdate is tribasic.

Action of Sulphuretted Hydrogen upon the Salts of Cobalt.—H. Baubigny.—(See p. 253).

On the Ammonium Phosphites.—L. Amat.—Three ammonium phosphites have been described by Wurtz. The mono-metallic phosphites of the alkaline metals are unknown, the only ammonium compound described being the di-ammonium phosphite. The author has obtained a salt to which he gives the formula $(PO_3HO)NH_4O,HO$.

The Double Silver-Potassium Carbonate.—A. de Schulten.—The compound obtained on pouring a little silver nitrate into a strong solution of potassium carbonate mixed with potassium dicarbonate is a white amorphous precipitate which, on standing, becomes transformed into white microscopic crystals, which become yellow, and are decomposed if the liquid in which they are formed is diluted. The formula of the compound is $AgKCO_3$.

Certain Salts of Aniline.—A. Ditte.—This paper contains a description of aniline molybdate, tungstate, vanadate, iodate, chlorate, and borate.

Formation of Normal Amylic Alcohol in the Fermentation of Glycerin by Bacillus Butylicus.— E. C. Morin.—This paper contains an experimental verification of the fact announced in its title. It is remarked that all the products of this fermentation are normal.

Bulletin de la Société d'Encouragement. Series 4, Vol. ii., No. 19, July, 1887.

Manufacture of Soda from Sodium Sulphate by Means of Carbon Monoxide and Dioxide.—This process, devised by Kayser, Young, and Williams, of Buffalo, is founded upon the following reaction—

$$Na_2SO_4 + CO_2 + CO = Na_2CO_3 + SO_2 + CO_2.$$

The temperature at which the two gases act upon the salt cake is a dull cherry red; sulphurous acid escapes and is utilised for converting salt into salt-cake by the injection of oxygen and steam, as in the Hargreaves process. The operation, which is conducted in retorts, is continuous without discharge of the sulphate, and is completed by the admission of the mixed carbon gases, which are incorporated with the masses by means of an aspirator. The mixture of the two gases, in equal equivalents, but with a slight excess of carbonic acid, is generated in a special furnace, which produces in the lower part carbon monoxide, and in the upper part carbon dioxide (*Dingler's Polyt. Journal*).

Journal fur Praktische Chemie.
New Series, Vol. xxxv., Part 9.

On New Reactions with Sodium Acetacetic- and Sodium Malonic Ethers.—A. Michael.—The author examines the behaviour of these ethers with the aldehyds, the ketones, phenyl-isocyanate, the anhydrides of bibasic acids, the inorganic anhydrides, the phenoles, sulphur, urea, the sulph-ureas, and aldehyd-ammonia.

The Action of Chlorine upon Organic Sulpho-cyanides.—J. W. James.—In connection with his investigation of ethylene-chlor-sulphocyanide the author resumed this question formerly studied by Cahours and Riche, and examined the action of chlorine upon methyl and ethyl sulpho-cyanides in the hope of obtaining chloro-sulphocyanides. But the radicle cyanogen was at once eliminated by chlorine as cyanogen chloride.

MISCELLANEOUS.

The Chair of Chemistry at King's College.—We are pleased to announce that the Council have elected Dr. J. Millar Thomson to the Chair of Chemistry vacant through the death of Prof. Bloxam. Dr. Thomson's connection with the College began with the post of Junior Demonstrator in 1871, and the Senior Demonstratorship in 1879, which he has held up to the present time.

Royal Institution of Great Britain.—The following are the probable arrangements for the Friday Evening Meetings before Easter, 1888:—

Jan. 20th. The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., Professor of Natural Philosophy at the Royal Institution.—"Diffraction of Sound."

Jan. 27th. Joseph Thomson, F.R.G.S., Gold Medallist of the Royal Geographical Society.—"The Exploration of Masai-Land."

Feb. 3rd. Frank Crisp, LL.B., B.A., V.P. and Treas. Linn. Soc., Sec. R.M.S.—"Ancient Microscopes."

Feb. 10th. W. H. Preece, F.R.S.—"Safety Lamps in Collieries."

Feb. 17th. Sir Henry Doulton.—"Some Developments of English Pottery during the last Fifty Years."

Feb. 24th. The Very Rev. G. Granville Bradley, D.D., Dean of Westminster.—"Westminster Abbey."

March 2nd. C. Meymott Tidy, M.B., F.C.S.—"Poisons and Poisoning."

March 9th. Leslie Stephen, M.A.—"S. T. Coleridge."

March 16th. John Murray, Esq.—"Structure, Origin, and Distribution of Coral Reefs and Islands."

March 23rd. Sir Frederick Bramwell, D.C.L., F.R.S.

MEETINGS FOR THE WEEK.

Monday, 19th.—Medical, 8.30.

Tuesday, 20th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.

Wednesday, 21st.—Geological, 8.
—— Meteorogical, 7.

Thursday, 22nd.—Royal, 4.30.

Friday, 23rd.—Quekett Club, 8.

CENTRAL INSTITUTION
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TECHNICAL CHEMISTRY.—A Course of Lectures on the Chemistry of OILS (Mineral and Vegetable) and FATS, by Dr. A. K. MILLER, Assistant in Research Laboratory, will commence on Monday, January 23rd, at 4 p.m. Fee for the Course, £1.

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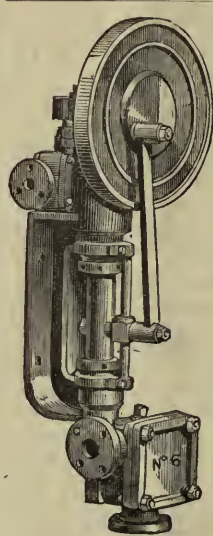

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THE CHEMICAL NEWS.

Vol. LVI. No. 1465.

A DELICATE THERMOMETER SUITABLE FOR LECTURE PURPOSES.

By SYDNEY YOUNG, University College, Bristol.

In a lecture recently delivered to the Bristol Naturalists' Society I wished to show the existence of the point of maximum density of water by means of a closed glass bulb containing such a quantity of mercury that it would sink at 0°, float at about the point of maximum density, and sink again at higher temperatures. (It may be mentioned that owing to the expansion of the glass the apparent point of maximum density is about 6° instead of 4°).

In order that the changes of temperature of the water might be made apparent to the audience a thermometer was required with a stem of internal diameter sufficiently great to allow of the liquid within the tube being seen at distance, and yet with a bulb of moderate dimensions. An air thermometer with a large bulb would answer the first of these requirements, but not the second. An air thermometer of a form commonly employed to show the expansion of air with rise of temperature gives, however, very good results when a volatile liquid, such as ether, is substituted for mercury or sulphuric acid, for then, in addition to the expansion of the air, we have the increased vapour pressure of the liquid. The apparatus constructed is shown in the diagram. The cylindrical tube containing air confined by ether has an internal diameter of 17 m.m., that of the narrow tube being 2·8 m.m. The length of the cylinder is 130 m.m., and the length of the tube above the cylinder about 700 m.m. The wider tube above this is sufficiently large to contain the ether which is expelled when the temperature rises to about 24°.

As most colouring matters are insoluble in ether, it was found convenient to add a little absolute alcohol; aniline red dissolves in this mixture, giving a coloured solution, which is visible at a long distance, and the delicacy of the instrument is not very greatly reduced by the alcohol.

Knowing the volume of air at 0° and then vapour pressures of ether at each degree, it is possible to calculate the rise of the column of ether (when the pure substance is employed) for any increment of temperature starting from 0° C.

Let the barometric pressure = B.
" volume of air (and vapour) at $t°=V_t$.
" vapour pressure of ether at $t°=\pi_t$.
" pressure of the air at $t°=P_t$.
" pressure of the column of ether in millimetres of mercury $=p_t$.

Let the area of a cross section of the ether in the cylinder = A.
Let the internal area of the tube $= a$.
" rise of the column of ether for $t°= l$.
" specific gravity of ether $= s'$.
" specific gravity of mercury $= s$.

Then for the pressure on the surface of the ether in the cylinder we have the equations :—

at 0°—

$$P_o + \pi_o = B + p_o \text{ or } P_o = B + p_o - \pi_o$$

and at $t°$—

$$P_o \times \frac{273+t}{273} \times \frac{V_o}{V_t} + \pi_t = B + p_o + \frac{s'}{s}\left(\frac{V_t - V_o}{A} - \frac{V_t - V_o}{a}\right)$$

$$= B + p_o + (V_t - V_o).\frac{(A+a)s'}{A.a.s}$$

For $\frac{(A+a)s'}{A.a.s}$ write α.

Then—

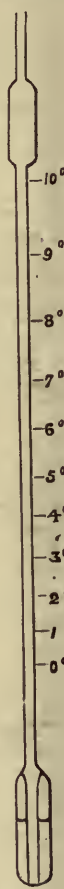
$$V_t^2 + V_t\left(\frac{B + p_o - V_o\alpha - \pi_t}{\alpha}\right) = \frac{V_o \times P_o \times (273+t)}{273\,\alpha}$$

from which V_t may be calculated.

The rise of the column of ether will be—

$$l = \frac{V_t - V_o}{a}$$

It is more convenient, however, to construct the scale by immersing the cylinder in water at various temperatures, noting the height of the column at those temperatures. By plotting these results a curve may be constructed from which the heights of the column at each



degree or fraction of a degree may be read. A paper or cardboard scale may then be constructed with very little trouble.

The indications of the instrument are affected by changes of the barometer, and for accurate work it would be advisable to connect the open end of the tube with a reservoir of air kept at a constant pressure. The delicacy of the instrument might be greatly increased by reducing the pressure of the air.

An idea of the results obtainable may be gathered from the following data, which refer to the instrument actually constructed in which, as already mentioned, a mixture of ether and alcohol was employed.

Total rise of column for 10° C. = 510 m.m.
Rise of column for increment of 1°—

from 0° to 1° = 40 m.m.
" 9° to 10° = 82 m.m.

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

In making a quantitative examination of oleo-margarine I found, after separating out the cotton-seed oil, the residue exhausted with carbon disulphide contained cocoa-nut oil and animal fat.

The oleo-margarine was so entirely free from the smell and taste peculiar to cocoa-nut oil that I feel inquisitive as to what could have been added to have so completely masked its smell and flavour: when separated from the cotton-seed oil its smell was most decided; the firmness of the oleo-margarine was due in a great measure to cocoa-nut oil.

I thought it would be interesting to examine the action of sulphur chloride on this oil. When cocoa-nut oil is dissolved in carbon disulphide and sulphur chloride added, in the same way as previously recommended, it behaves like butter, but on evaporating the carbon disulphide it turns much darker in colour. It does not turn cloudy, and dissolves completely in CS_2. A mixture was made of 3 parts cocoa-nut oil and 1 part cotton-seed oil, and treated in exactly the same way as the cocoa-nut oil; it kept perfectly bright and clear.

I find that the addition of a certain quantity of cotton-seed oil conceals the taste and smell of cocoa-nut oil; but the strong rancid odour of the animal fat which separates from the oleo-margarine containing these oils is very pronounced, especially if kept in a warm place for a few hours.

The following will explain the application of this reagent for quantitative results:—

	Grammes.
Weight of oleo-margarine taken	5·76
,, cotton-seed oil added	5 24
,, residue (after treatment with sulphur chloride), &c. ..	7·74
,, due to cotton-oil added ..	5·67
,, increase due to cotton-oil in oleo-margarine	2·07
,, cotton-oil actually present in oleo-margarine	$\frac{5·67}{5·24} \times 2·07$

= 1·91 grammes = 33·3 per cent.

Two experiments with cotton-seed oil alone, as used in this analysis, gave solid residues within 5 per cent of each other. This difference is much greater than need be incurred after a little practice.

The substance washed out with carbon disulphide was evaporated, and every trace of disulphide removed. Water was added to remove the soluble portion and to decompose any free chloride present, when a dark altered oil or fat floated on the surface, and a white adherent fat stuck to the sides and bottom of the flask; evidently this substance had not been acted on by the chloride. It was in hard white tufts, and smelt strongly of cocoa-nut oil.

Cocoa-nut oil, in presence of most oils and fats, is not so easily acted on by sulphur chloride, unless in large excess. The altered oils and fats appear to impede the solubility of cocoa-nut oil; hence it is quite easy to recover, from the experimental mixture of cocoa-nut and cotton-seed oils, the cocoa-nut oil perfectly white and solid. The procedure was in all respects identical with that given for the quantitative results obtained for oleo-margarine.

This portion of the subject is sufficiently interesting and novel, that I hope to deal with it more fully on a uture occasion.

A fact which adds importance to this method of testing is that, if cotton-seed oil or any similarly affected oil be added to oleo-margarine or pure butter, the well-washed solid product obtained is coloured by a portion of the animal fats, which is so far pronounced that no difficulty can arise in deciding whether the animal fats are those belonging to pure butter or whether they belong to certain soft fats or oleins.

ON THE DETERMINATION OF ARSENIC AS THE PENTASULPHIDE.

By LEROY W. McCAY.

In 1878 Bunsen,* in an article upon the separation o antimony from arsenic, showed that by treating an acidified solution of arsenic acid kept alternately hot and cold for a long time, with an excess of sulphuretted hydrogen and permitting the whole to stand for a day, the arsenic was completely precipitated as the pentasulphide. He recommends this sulphide as an excellent form in which to determine arsenic.

I have of late been experimenting a good deal in connection with the conditions regulating the formation of the highest sulphide of arsenic, and have obtained the same results as those obtained by Bunsen. The precipitate obtained by passing a stream of sulphuretted hydrogen through the acidified solution of an alkali arseniate is undoubtedly pentasulphide of arsenic.†

Further, I have discovered a new and rapid method for preparing the sulphide by the action of sulphuretted hydrogen upon arsenic compounds, whereby it is obtained in a state of great purity. Aside from its theoretical importance, the method is of immediate value in its bearing upon the quantitative determination of arsenic. The principal objection to the Bunsen method lies in the long time and large quantities of sulphuretted hydrogen gas necessary to effect a complete separation. Chemists who have had any experience in the matter are well aware o how annoying the sluggish precipitation of arsenic by sulphuretted hydrogen from an arsenic acid solution can be.

It will therefore doubtless prove a relief to many to know that a complete precipitation of the arsenic in the form of the pentasulphide is possible in one hour.

Some time ago I published in the CHEMICAL NEWS (vol. li., No. 1320, March 13, 1885) an article upon the reduction of arsenic to arsenious acid by means of strong sulphurous acid, the reduction being accomplished in hermetically sealed bottles, and at a temperature corresponding to that of a boiling.water-bath. In a subsequent paper, which appeared in *American Chemical Journal* (vii., p. 373), I showed how the idea could be made the basis of a method for estimating arsenic with great speed and accuracy.

Lately, while engaged in making some determinations of arsenic according to Bunsen's method, the thought struck me that perhaps the long and disagreeable precipitation of the arsenic might be avoided and the separation be easily and rapidly accomplished by making use of the same device employed in reducing arsenic to arsenious acid. A single experiment confirmed my expectations; the precipitation of the element was complete in one hour.‡ Indeed, the bottle had hardly been in the boiling bath a minute before the yellow pentasulphide commenced to come down. The bottle used in all my experiments has a capacity of about 200 c.c. The stopper and neck of the bottle were treated with a little fine emery powder, so as to produce a perfectly air-tight joint. By wetting a small piece of cloth, stretching it down tightly over the stopper, and tying the ends firmly to the sides of the neck of the bottle with a piece of cord also wetted, the danger of the stopper being thrown out during the heating is rendered very slight. I have generally thrown a piece of wire gauze over the bath during each experiment, but this is really

* *Ann. d. Chim.*, cxcii., 305.

† This is in direct opposition to the statements of Ludwig, Wackenroder, H. Rose, and Fuchs.

‡ See my preliminary note in the CHEMICAL NEWS, vol. liv., p. 287.

unnecessary, as I have never yet had a bottle broken by the internal pressure.

A saturated solution of sulphuretted hydrogen, at the ordinary temperature, contains about three times its volume of the gas. 200 c.c. of a dilute solution of arsenic acid would then absorb, roughly speaking, 200 × 3 = 600 c.c. sulphuretted hydrogen gas. But 1000 c.c. sulphuretted hydrogen gas = 1·5199 grms.; consequently 600 c.c. gas = 0·912 grm. Now, 150 grms. As = 160 grms. S = 170 grms. H_2S for complete saturation. Hence the quantity of sulphuretted hydrogen absorbed by 600 c.c. solution—namely, 0·912 grm.—would suffice for precipitating 0·805 grm. arsenic. But since the gas must be present in large excess,* the amount of arsenic capable of being precipitated as the pentasulphide would be considerably less than 0·805 grm. I have found anything from 0·1 to 0·3 grm. to be a convenient quantity for a determination. The pentasulphide separates out in a thick skin, which adheres but slightly to the bottom and sides of the bottle. If the bottle, when cool, be inclined, the skin loosens itself, and one part can be made to overlap the other in a way which bears a striking resemblance to an omelette. The precipitate can be removed from the bottle without the slightest difficulty. When the sulphide, with the exception of a few particles, has been brought on the filter paper, a little water is put in the bottle, the stopper is inserted, and the whole violently shaken for a few moments. Thus the particles are freed from any adhering air, are broken up, and can then be removed from the bottle so completely that not a yellow speck can be detected on the glass. I used for test analyses the following solutions:—

1. N/10 solution of arsenic acid: This was prepared by oxidising 4·95 grms. pure dry arsenious acid with fuming nitric acid, evaporating, neutralising with ammonia, and diluting to a litre.

2. A standard solution of di-hydrogen potassium arseniate: This was prepared by dissolving about 25 grms. of the salt in water and diluting to two litres. By careful analysis 25 c.c. = 0·1292 grm. As, and 50 c.c. = 0·2585 grm. As.

The first quantitative experiments were made precisely as follows:—

A. The solution of arsenic acid was pipetted into the bottle, diluted to about 150 c.c., and rendered strongly acid with concentrated hydrochloric acid. The solution was treated with sulphuretted hydrogen gas until a decided opalescence made its appearance, when the bottle was closed, the stopper firmly tied down, and the whole placed in the boiling water-bath and here kept for one hour. At the end of the hour the bottle was removed from the bath, allowed to cool, and violently shaken so as to cause the pentasulphide to subside rapidly, leaving the supernatant liquid clear. Its contents were then filtered on a weighed filter paper, dried at 110° C. The precipitate was washed with water until a few drops of the filtrate gave no reaction for chlorine with nitrate of silver, and then, in regular order, six times with alcohol, four times with bisulphide of carbon, and again four times with alcohol. I used the pump in all cases. The drying was done at 110° C. and to constant weight. Two hours invariably proved sufficient.

Taken.	Calculated. Grm.	Found. Grm.
I. 20 c.c. N/10 H_3AsO_4	0·1550 As_2S_5 = 0·0750 As	0·1555 As_2S_5 = 0·0752 As
II. 30 c.c. N/10 H_3AsO_4	0·2325 As_2S_5 = 0·1125 As	0·2330 As_2S_5 = 0·1127 As
III. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3871 As_2S_5 = 0·1873 As
IV. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3879 As_2S_5 = 0·1877 As
V. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3875 As_2S_5 = 0·1875 As
VI. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3870 As_2S_5 = 0·1872 As

* See Fresenius, "Qualitative Analysis," 15te Auflage.

To see whether the trisulphide, when heated under pressure and in the presence of excess of sulphuretted hydrogen and a little air, could be made to take up sulphur and pass partially into the state of pentasulphide, I made the following experiment:—

50 c.c. N/10 arsenious acid were brought into the bottle, strongly acidified with hydrochloric acid, and saturated with sulphuretted hydrogen. Yellow trisulphide of arsenic was of course immediately precipitated. The bottle was closed and the whole heated in the boiling water-bath for one hour. I obtained, after filtering, washing, &c., 0·3095 grm. As_2S_3 = 0·1887 grm. As, whereas theory demands 0·1875 grm. The result is a trifle high, it is true, but the experiment certainly proves that no pentasulphide can be formed by heating together the trisulphide, sulphuretted hydrogen, and *small* quantities of air.

To avoid the use of alcohol and carbon bisulphide in washing the precipitate, I proceeded as follows, and, as will be seen, with complete success:—

B. The solution, after having been brought into the bottle and acidified with hydrochloric acid, was diluted with freshly boiled water until the bottle was nearly full, and then saturated with sulphuretted hydrogen. By so doing almost all the air was expelled from the bottle, and a subsequent separation of sulphur from the sulphuretted hydrogen by the action of any free oxygen rendered n to impossible.

The rest of the process was then conducted exactly as has been already described. The sulphide was washed with water until the filtrate was free from chlorine. I found it well, in order to promote the subsequent drying of the precipitate, to replace the water adhering to the same by running a small quantity of alcohol through the filter. This, however, is not necessary.

Taken.	Calculated. Grm.	Found. Grm.
I. 25 c.c. standard H_2KAsO_4	0·2670 As_2S_5 = 0·1292 As	0·2675 As_2S_5 = 0·1294 As
II. 25 c.c. standard H_2KAsO_4	0·2670 As_2S_5 = 0·1292 As	0·2671 As_2S_5 = 0·1292 As
III. 25 c.c. standard H_2KAsO_4	0·2670 As_2S_5 = 0·1292 As	0·2670 As_2S_5 = 0·1291 As
IV. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5350 As_2S_5 = 0·2588 As
V. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5331 As_2S_5 = 0·2580 As
VI. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5333 As_2S_5 = 0·2581 As
VII. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5335 As_2S_5 = 0·2582 As
VIII. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5351 As_2S = 0·2588 As

50 c.c. of this standard solution were precipitated under pressure and washed according to the first method, *i.e.*, with water, until the filtrate was free from chlorine, then six times with alcohol, four times with bisulphide of carbon, and again three times with alcohol. I obtained 0·5326 grm. As_2S_5 = 0·2578 grm. As. The weight of the sulphide is somewhat below the required figure, but the corresponding amount of arsenic differs from the calculated quantity by only 0·0006 grm. It seemed well to analyse this standard solution by precipitating and weighing the arsenic as the trisulphide.

To do so, I reduced 50 c.c. by heating the same with sulphurous acid under pressure, boiled off the sulphurous acid remaining, and precipitated the arsenic with sulphuretted hydrogen. The precipitate was carefully filtered, washed, and dried according to Bunsen's directions. I obtained 0·4237 grm. As_2S_3 = 0·2583 grm. As. The amount required is 0·2584 grm. As.

To further test this method of determining arsenic, I had a friend make up a solution of arseniate of potassium,

* It seemed possible that, with the aid of the air remaining in the bottle the pentasulphide might be formed in accordance with the equation $As_2S_3 + 2H_2S + 2O = As_2S_5 + 2(H_2O)$.

such that every 50 c.c. contained between 0·2 and 0·3 grm. of arsenic. I made two analyses of this solution and obtained (1) 0·1336 grm. As, and (2) 0·1331 grm. As. The first precipitate was washed as Bunsen directs, the second according to my own method. The calculated result, as I was informed, was 0·1344 grm. As. The salt, however, is not absolutely pure as I have convinced myself by frequent and careful analysis. Allowing for the small amount of impurity, it will be seen that the agreement between the calculated quantity and the results found is entirely satisfactory.

I suggest, then, that when occasion arises for making an estimation of arsenic according to Bunsen's method, the modification here discussed be used. The process is a great improvement upon the Bunsen mode of procedure, for the following reasons:—1. It is remarkably rapid; 2. The quantity of sulphuretted hydrogen necessary for precipitation is reduced to a minimum; 3. No alcohol nor bisulphide of carbon is necessary for washing; and 4. The pentasulphide does not stick to the sides of the bottle, but separates out in such a state that every trace can be removed without even the aid of a feather.—*American Chemical Journal*, June, 1887.

ON THE

CHEMICAL COMPOSITION OF HOWLITE,

WITH A NOTE ON THE

GOOCH METHOD FOR THE DETERMINATION OF BORACIC ACID.

By S. L. PENFIELD and E. S. SPERRY.

THIS interesting mineral was first identified as a new species by Prof. Henry How,* of Windsor, Nova Scotia, who named it silicoborocalcite, assigning to it the composition—

$$2CaO.SiO_2 + 2(CaO_2.BO_3.HO) + BO_3.3HO,$$

written in the old system and in the form suggested by Prof. How. He described it as occurring in dense, chalk-like nodules, in the gypsum beds at Brookfield, near Windsor, N.S. In later papers† he mentions its occurring in four distinct localities near Windsor, the nodules being sometimes as large as a man's head and composed of minute scaly and silky crystals. The name howlite was substituted for silicoborocalcite by Prof. J. D. Dana, and used by him in the fifth edition of his "System of Mineralogy."

The specimen which we have examined was collected in the gypsum quarries at Windsor, N.S., by Mr. Charles G. Rupert, of Minneapolis, Minn., who generously presented it to the Mineralogical Department for investigation. It consisted of an egg-shaped nodule about 1¼ inches in its greatest diameter, embedded in massive gypsum. The nodule was composed of intergrown microscopic needles, which under the microscope were resolved into flattened prismatic forms, having somewhat the shape of thin stilbite crystals, the largest 0·23 × 0·27 m.m., usually broken at the extremities, but occasionally terminated by two dome faces. In polarised light they showed parallel extinction, brilliant polarisation colours, red and yellow of the first order, according to the thickness of the crystal, the longer axis being the axis of least elasticity. In convergent light an obtuse bisectrix was very indistinctly seen, the plane of the optic axes being at right angles to the longer axis of the crystal. The crystallisation is therefore probably orthorhombic. Owing to the slight solubility of the mineral in water its specific gravity was taken in alcohol and found to be 2·59 referred to water. A sample was taken for analysis by breaking into the nodule and carefully freeing from adhering gypsum by hand-picking, but it was impossible to obtain the borate perfectly pure, a little SO_3 being found on analysis which undoubtedly resulted from adhering gypsum. The results of analysis of the air-dry powder are as follows:—

	I.	II.	Mean.
SiO_2	14·65	14·74	14·70
B_2O_3	42·68	42·70	42·69
CaO	28·22	28·19	28·20
Na_2O	0·55	0·47	0·51
K_2O	—	0·12	0·12
H_2O	12·01	11·94	11·97
SO_3	1·93	2·10	2·01
			100·20

Below the results are given after deducting 4·32 per cent of gypsum, corresponding to 2·01 per cent of SO_3, and calculating to 100·00 per cent, together with the analysis of How and the theoretical percentages derived from our ratio.

		Ratio.			How.	Calculated for $H_5Ca_2B_5SiO_{14}$
SiO_2	15·33	0·255		2·00	15·25	15·31
B_2O_3	44·52	0·636		5·00	[44·22]	44·65
CaO	27·94	0·498	0·507	3·99	28·65	28·56
Na_2O	0·53	0·008				
K_2O	0·13	0·001				
H_2O	11·55	0·641		5·04	11·84	11·48
	100·00				100·00	100·00

The ratio of $SiO_2 : B_2O_3 : CaO : H_2O = 2 : 5 : 4 : 5$ very closely, with a small part of the CaO replaced by Na_2O and K_2O. This is exactly the ratio obtained by Prof. How, but the analysis is of importance as proving the identity of this curious boro-silicate as a distinct species, the original analysis having been made on dense chalk-like varieties, and the most important constituent, B_2O_3, being determined by difference. The air-dry powder of the mineral lost water slowly at 100° C., but soon came to a constant weight at 150° C., losing 0·83 per cent, the mineral suffering no further loss by heating to 360°. The loss of 0·83 per cent corresponds closely to 0·90 per cent, the amount of water contained in the 4·32 per cent of gypsum which the analysed portion contained. Thus the loss of water at 150° C., as well as the SO_3 determination and the occurrence of the nodule in massive gypsum, suggest that there was a slight impurity of gypsum in the material which was analysed. The fact that the mineral does not part with its water at 360° C. indicates that the hydrogen is very firmly united in the molecule, probably as hydroxyl. The mineral is therefore a very acid silico-borate, and its formula may be written $H_5Ca_2B_5SiO_{14}$, differing essentially from the more common silico-borates of calcium, datolite, and danburite, in containing much less silica and more boracic acid, causing the mineral to be classified more naturally with the borates than with the silicates.

On igniting the mineral in a closed tube water is given off which reacts strongly for boracic acid with turmeric paper; the water in the above analysis was therefore obtained by ignition and absorption in a chloride of calcium tube. The boracic acid was determined by the admirable method suggested by Prof. F. A. Gooch.* The other constituents were determined by the usual methods.

Note on the Gooch Method for the Determination of Boracic Acid.

Before commencing the above analysis we carefully reviewed the method described by Prof. Gooch,† making a number of determinations of B_2O_3 in borax in order to become fully acquainted with the method. The distilling

* *Phil. Mag.*, IV., xxxv., p. 32.
† *Ibid.*, IV., xxxvii., 270, and xxxix., 278

* *Am. Chem. Journal*, ol. ix., p. 23, and CHEMICAL NEWS, vol. lv p. 7, Jan. 7, 1887.
† *Loc. cit.*

apparatus described by him proved very satisfactory. The boracic acid in our experiments was set free by nitric acid, distilled over with methyl alcohol, and evaporated with a weighed quantity of ignited calcium oxide. Without the use of very large platinum crucibles the evaporation of the boric ether with slaked lime is attended with some difficulty. The calcium borate together with the excess of lime form as a thick crystalline precipitate at the bottom of the crucible, and if the methyl alcohol boils during the evaporation some of the precipitate will be carried mechanically out of the crucible; then, too, the very strong ignition of the CaO necessary to bring it to a constant weight is not so readily accomplished if the crucibles are very large.

The following method was found to give very good satisfaction, and can be used by anyone having an ordinary sized platinum crucible, and preferably a platinum dish:—The lime, after being ignited to a constant weight and slaked, is transferred to a large platinum dish and warmed with water till it becomes of a milky consistency; it is not necessary to remove all the lime from the crucible, the latter being put away and used later on. Strong ammonia is poured into the receiving flask of the distilling apparatus described by Gooch, and, after conducting the distillation as directed, the contents of the receiver are poured into the platinum dish containing the slaked lime, water being freely used in rinsing out the receiver. The dish is then placed on a triangle over the water-bath, or otherwise gently heated till the volatile products, methyl alcohol and ammonia, are driven off, which by boiling might cause mechanical loss. When these are removed the contents of the dish can be evaporated to dryness. The dried calcium borate and the excess of lime are now transferred to the crucible in which the lime was weighed, this being easily accomplished by moistening the contents of the dish with water and shoving the bulk of the precipitate into the crucible with a spatula; by rinsing with a little water and by using a rubber on the end of a glass rod all but a very little of the borate and lime can be transferred to the crucible; that which sticks too firmly to the dish can be dissolved in one or two drops of dilute nitric acid which is brought in contact with all parts of the dish with the rubber; the solution is then transferred and rinsed into the crucible. The transfer and washing can readily be made by using not over 30 c.c. of water, which can be contained in an ordinary student's crucible. The evaporation from this point goes on very simply, the borate drying out nicely on the water-bath. By placing the platinum crucible in a large porcelain one and gradually raising the heat to strong igniton the borate may be further dried out without any danger of snapping. The residue is finally ignited over the blast-lamp till a constant weight is obtained.

In slaking the lime we have found it convenient not to add the water directly to the ignited lime, causing danger from excessive heating and mechanical loss, but to place the open crucible on a watch-glass containing water and covered with a bell-jar: in this way the lime soon slakes, and, in case of special hurry, hot water may be placed in the watch-glass from time to time so that the atmosphere under the bell-jar will be thoroughly saturated; in this way the lime will become so thoroughly slaked in one or two hours that there will be no danger of excessive heating on further addition of water.

The following results were obtained, using in all cases about 1 grm. of crystallised borax and 1 grm. of lime:— B_2O_3 in borax, 36·55, 36·42, 36·58, 36·64, calculated 36·64 per cent.—*American Journal of Science* (Third Series, vol. xxxiv., p. 220).

The Chemical Composition of a Brandy from Charente-Inferieure.—E. C. Morin.—Even in natural brandies the proportion of the higher alcohols is too large to be neglected. They contain furfurol and the bases met with in fusel oils.—*Comptes Rendus.*

REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.*

The Committee on Indexing Chemical Literature respectfully presents to the Chemical Section its fifth annual report.

During the year Professor Charles E. Munroe completed and printed his Index to the Literature of Explosives, Part I., in an octavo pamphlet of forty-two pages. Part I. embraces the bibliography of the subject as found in the following complete sets of periodicals:—

Journal Royal United Service Institution, 1857—1885, 28 vols.

American Journal of Science, 1819—1886, 130 vols.

Philosophical Transactions (Royal Society), 1665—1882, 173 vols.

Revue d'artillerie, 1873—1884, 25 vols.

Proceedings U. S. Naval Institute, 1874—1885, 11 vols.

H. M. Inspector of Explosives (*Reports*), 1871—1885, 75 numbers; making in all no less than 442 volumes, which have been examined and indexed. In Part II., the author intends to continue with additional periodicals, and finally to give a subject and an author-index to the whole.

Dr. H. Carrington Bolton has published two brief bibliographical helps for chemists; the titles of which will be found in the list of Indexes at the close of this report.

Mr. A. Tuckerman of New York has completed an Index to the Literature of the Spectroscope, which will be printed by the Smithsonian Institution.

Though of local interest only, we mention in this connection a useful check-list of scientific journals published by a member of the Association. Mr. Clement W. Andrews has compiled a "List of the Scientific Periodicals in the Libraries of the various departments of the Massachusetts Institute of Technology [Boston], April, 1887." This list contains two hundred and forty-seven titles arranged alphabetically by the first word, with the exception of Official Reports. In connection with each title, indications are given of the particular departments of the Institute, nine in number, in which the periodical may be found.

Reports of progress have been received from the following gentlemen, on the indexes named:—

Professor F. W. Clarke, Specific Gravity Tables.
Professor W. H. Seaman, American Chemical Patents.
Mr. George F. Kunz, Gems and Precious Stones.
Mr. Clement W. Andrews, Milk Analysis.
Dr. F. E. Englehardt, Common Salt.
Dr. L. P. Kinnicutt, Meteorites.
Prof. Erastus G. Smith, Aluminium.
Mr. William Beer, Bibliography of Scientific Bibliographies.

The late lamented Professor Wm. Ripley Nichols left his Index to the Literature of Carbon Monoxide unpublished, yet so well advanced as to permit its extension and completion; this has been undertaken by Mr. Augustus H. Gill, of the Massachusetts Institute of Technology.

Offers of voluntary coöperation have been received from two chemists: Dr. Frank W. Traphagen, of Staunton, Va., has undertaken to compile an Index to the Literature of Bromine, and Mr. A. P. Bjerregaard, of the Astor Library, New York, has begun work on an Index to the Literature of Chromium, both subjects having been suggested by the Committee.

As stated in an earlier report the Committee deems it advisable to note important bibliographical undertakings which come under its observation. Attention is called to the extensive Index to Meteorological Literature now preparing by Mr. C. J. Sawyer, of the Signal Office, War

* *From the Proceedings of the American Association for the Advancement o Science*, Vol. xxxvi.

Department. It is a classified index containing about 50,000 titles on meteorology and terrestrial magnetism, including separate works, memoirs, and published observations. It will be accompanied by a full author-index. The date of publication of the manuscript will depend on congressional action.

When committees for the preparation of indexes and bibliographies of special topics are appointed by both the American and the British Associations for the Advancement of Science, it is eminently desirable that they should coöperate as far as practicable. A beginning has already been made in the direction of an International Committee by the appointment of one of the members of our Committee (Prof. Leeds) to serve on the Committee of the British Association for indexing the literature of Solution. The circulars issued for the members contain a scheme of classification and a list of the periodicals, thirty-one in number, which it is proposed to index. The project also calls for original work. Those desiring further information should address W. W. S. Nicol, the Secretary, at the Mason Science College, Birmingham.

Members of the Chemical Section who attended the Buffalo meeting will remember that one of the Committee discussed in a brief article the desirability of greater uniformity in the abbreviations of Journal titles and suggested the formation of a Standard List for chemistry. The proposition was favourably received by the Section, and the Committee, reinforced by Prof. C. K. Wead and Mr. S. H. Scudder, has devoted much thought and time to the preparation of such a list. During the progress of the work the Committe was favoured with suggestions from Mr. Clement W. Andrews, of the Massachusetts Institute of Technology, and from Prof. William Frear, of the Pennsylvania State College. Both of these gentlemen kindly drew up lists of abbreviations for the use of the Committee. The Committee does not think it necessary in this place to detail the many difficulties encountered, but present to the Section a succinct statement of the principles by which it was governed in preparing the Standard List.

Principles for Abbreviation of Titles.

1. Follow established usages when possible.
2. While seeking brevity avoid obscurity.
3. Brevity and perspicuity are not to be sacrificed to consistency.
4. Follow the rules 1, 3, and 4 as laid down by Dr. J. S. Billings, viz.:—"(1) Follow the exact order of words of the title. (3) Follow the orthographical usages of each language; this rule disposes of capitalisation. (4) Attain uniformity as far as possible."
5. If possible, indicate languages of titles by use of articles and conjunctions, or by spelling.
6. When necessary to differentiate add names of editors or places of publication.
7. Abbreviations should be intelligible without a key.
8. Optional words are placed in parentheses.
9. Obscure journals require fuller abbreviations than those frequently cited.

These principles were adopted after personal conference and correspondence, by a majority of the Committee; Dr. Alexis A. Julien, however, though welcoming this provisional list, expressed the wish for briefer abbreviations, and at his request we insert a summary of his views.

Dr. Julien thinks further contraction of the abbreviations desirable, chiefly by omission of vowels, even if established usages are sometimes abandoned. He thinks that consonants indicating roots philologically are in many cases sufficient; such as *Grn.* for *Giorn.*, &c.; he favours the following *Ch.* for *Chem.* and for *Chim.*, since the articles or conjunctions indicate the languages. Where the title of a journal is not readily confounded with that of any other he favours utmost contraction. He thinks the Standard List of Abbreviations will be more useful and more widely adopted if the abbreviations are shortened to a greater degree than in the subjoined list.

Mr. S. H. Scudder also dissents from the views of the majority of the Committee, approaching those of Dr. Julien but not going so far. He favours omission of all articles, prepositions, and conjunctions, and regards the Provisional List of Abbreviations as burdensome and as supposing an unreasonable lack of acquaintance with names of Journals. He also somewhat prefers adding place of publication instead of name of editor when necessary to differentiate, and would always end abbreviations (unless elliptical) with a consonant. He suggested several shorter contractions than those of the manuscript submitted to him, which the Chairman has ventured to incorporate in the Provisional List.

The majority of the Committee took a strongly conservative view of the matter. They felt that the abbreviations should in every case suggest to one moderately familiar with chemical periodical literature the name of the Journal indicated; they therefore avoided the use of symbols, or single letter abbreviations except in the sole instance of "J" for journal—already conventional. At the same time the abbreviations in the following list will be found briefer and more easily recognised than those in the Catalogue of Scientific Papers published by the Royal Society, or in the Index-Catalogue of the Library of the Surgeon General's Office. Yet they believe they are full enough to be used without obscurity, in such Catalogues as these, covering almost the whole range of scientific journals.

The members of the Committee do not regard this report as the proper place to explain fully the reasons which have led to the adoption of each of the two hundred abbreviations submitted herewith; nor do they feel called upon to defend their choice. But they do earnestly desire that, before their critics undertake further condensation in certain cases that seem to be needlessly extended, they shall examine the titles of a compendious bibliography of scientific periodicals. By so doing they will perceive the necessity of differentiation, and that provision has been made to avoid confounding journals having closely similar titles.

The Committee also realises that it may often be desirable to shorten a given abbreviation for special reasons, as for example in printing tables, or where a large number of citations are made from a single journal. This conversion of abbreviations into "symbols" must be left to the judgment and necessities of individuals.

In presenting to the Section the draft of a list of abbreviations for their scrutiny and approval or disapproval, the Committee desires it to be distinctly understood that the list is a provisional one and subject to such amendments as the Section may direct. The Committee respectfully suggests that the Provisional List annexed to this Report be printed for use of members of the Chemical Section, and that the Section take no action upon the list as a whole until the meeting of 1888. In the interim the Provisional List can be subjected to the test of usage, and improvements or amendments which suggest themselves on trial can be recorded. All suggestions will be welcomed by the Chairman of the Committee, to whom they should be addressed.

Several years having elapsed since the publication of a list of the indexes in print, the Committee deems it advisable to re-publish the list brought up to date, together with memoranda indicating where the indexes can be obtained. Unfortunately some are out of print.

The Committee again thanks the Association and the Smithsonian Institution for services which save the Committee from incurring the expenses of printing and mailing reports.

The Committee begs leave to refer chemists receiving this report to their oft-announced appeals for voluntary co-operation in the work which it has in charge. Sample copies of Indexes and other information can be had by

addressing the chairman, care of the Smithsonian Institution.

H. Carrington Bolton, *Chairman.*
F. W. Clarke, (absent in Europe).
Albert R. Leeds.
Alexis A. Julien.
John W. Langley.
Samuel H. Scudder.
C. K. Wead.

(To be continued).

NOTICES OF BOOKS.

The Chemistry of the Sun. By J. Norman Lockyer, F.R.S. London and New York: Macmillan and Co.

The purport of this work may be at once gathered from the two mottoes which the author has placed at the head of his preface. From Dalton, one of the most sober and least imaginative of modern chemists, he quotes the admission that "We do not know that any one of the bodies denominated elementary is absolutely indecomposable." From Graham's "Researches" (p. 299) he cites the passage—"It is conceivable that the various kinds of matters, now recognised in different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of all bodies."

Thus, Mr. Lockyer does not seek to give us here a summary of celestial spectroscopy. He does not even speculate on the origin and nature of the sun; but he asks what light does a spectroscopic study of the sun and of the fixed stars throw upon the fundamental problem of chemistry,—the real nature of our so-called elements?

Hence any inquiry into the accuracy or the completeness of the history of spectroscopy, which occupies the first chapters of this work, is really beside the main question. Are our elements absolutely distinct, having either existed from all eternity or having been created such as we now find them; or are they compounds of some simpler bodies, perhaps different forms of one primordial matter? Are they capable of decomposition at extreme temperatures and of again re-uniting to their former condition as they cool? For a reply Mr. Lockyer refers us to the phenomena detected in the sun and the fixed stars by spectroscopic investigation. He appeals, in the first place, to the law of continuity. At every increase of temperature—which is *the* dissociating power—bodies within the temperatures at our command are separated from each other. To chemists such separations are so familiar that instances would be needless. We then ask, with the author, Is a temperature higher than any yet applied to act in the same way as each higher temperature which has yet been applied has done? Or is there to be some unexplained break in the uniformity of Nature's processes? There are minds to whom this appeal, in the absence of distinct evidence to the contrary, will seem conclusive. There are others, including all opponents of Evolution, who refuse to recognise the law of continuity wherever it has not been already established. To such minds the author has, therefore, to address himself. Have we therefore any evidence that with increasing temperature we have increasing dissociation, or, in other words, increasing simplification of the matter exposed to such temperature? Surely we have: quite independent of Mr. Norman Lockyer and his hypothesis we recognise in the hottest stars, such as Sirius and Vega, a spectrum remarkable for its simplicity. "The lines in their spectra are matched by lines which we see in the spectra of hydrogen, magnesium, and perhaps of sodium," the first greatly predominating, and the two latter substances being but feebly indicated.

We next come to a second class of stars, to which belongs our sun. Here we find evidence of a reduced temperature, whilst at the same time the indications of hydrogen are distinctly reduced and the complexity of the entire spectrum is wonderfully increased. It is here important to note that "the complexity" which we meet with in passing from the first class to the second is brought about by the addition of the lines produced by chemical substances of moderate atomic weight.

We now come to a third class. Here the hydrogen has altogether disappeared; the complexity of the spectrum has still further increased by the addition of lines mainly due to bodies of higher atomic weights.

If we again revert to these three classes of stars we find them in succession intensely hot, moderately hot, and less hot. As they become cooler the complexity of their spectra increases. The hottest class contain bodies only of very low atomic weight. In the intermediate we find an increased number of bodies, including those of medium atomic weight; whilst in the third cooler group not only is there evidence of a further increase in the number of bodies, but some of the higher atomic weights now make their appearance.

How, then, are we to interpret these facts? Are we to assume that the various stars differ quite accidentally in their chemical composition? Or shall we not rather conclude, as more agreeable with the facts, that we have here, with the progressive reduction of temperature, a progressive *association* of matter—existing previously in unknown states—so as to form our recognised elements?

Mr. Norman Lockyer has approached the question as a physicist; but he does not fail to produce the evidence of chemists in support of the possible dissociation of these elements. Dumas, Berthelot, Brodie, Sterry Hunt agree with Dalton and Graham that such elements can claim nothing higher than a provisional character, marking out not any definite ultimate stage in Nature, but merely the present limit of man's power,—a limit, we may venture to add, which even now shows signs of yielding. If temperature has no absolute maximum it may he hard to surmise to what lengths dissociation may be carried.

It is commonly asserted that we have never succeeded in our laboratories in decomposing an element; but what if the different spectra which we obtain when a substance is ignited by a Bunsen burner, and, on the other hand, by an arc light, indicate that in the latter case a dissociation—on the small scale—of the metallic particle is really taking place, and that we are working with matter similar to that which may be found in the laboratory of the Sun?

We have not space to follow Mr. Lockyer through the interesting comparison between the results which must flow from the hypothesis of dissociation and phenomena actually observed. Suffice it to say that they warrant us, in our opinion, in granting to this hypothesis at least a provisional assent, taking it as a guide in working and submitting it constantly to the test of renewed and extended operation. That it will be modified, corrected, extended, we fully believe; but we do not suppose that it will ever be rejected as a mere speculation.

We may here call attention to the researches of Prof. Grüenwald, which have recently appeared in the Chemical News, and which decidedly support Mr. Lockyer's hypothesis. He concludes that even hydrogen is a compound body, formed of helium, coronium, and a still rarer body.

Elementary Chemistry. By M. M. Pattison Muir, M.A., Fellow and Prælector in Chemistry of Gonville and Caius College, and Charles Slater, M.A., M.B., formerly Scholar of St. John's College, Cambridge. Cambridge: The University Press.

This work bears a well-marked relation to its companion volume, Pattison Muir and Carnegie's "Practical Chemistry." Some of the earlier chapters especially, in both, might—if very briefly summarised—be pronounced identical. In each we find discussed, *seriatim*, chemical

change, elements and not elements, mixtures and compounds, the conservation of matter, &c. But on examination it will be seen that in the two works these subjects are approached respectively from different sides, the one being complementary to the other.

In the very outset of "Elementary Chemistry" we find some explanatory remarks of great value. Say the authors—"The aim of Science is to see things as they are. But to see things as they are it is necessary to study the relations of things, because in Nature nothing is wholly cut off from other things, but everything is either a cause or a consequence of many other things, and is related in manifold ways even to things which may seem to be wholly unconnected with it." This is, beyond question, sound teaching.

The object of the book, we are further told, is "to place before the student an outline of the methods by which chemistry proceeds; to teach him some of the general laws of the science, and to show him that the laws are gained by studying natural occurrences."

No inconsiderable part of the work is devoted to an exposition of the periodic law and to the study of the elements as arranged in accordance with that law. This is a very valuable feature, the more so as in many elementary chemical treatises it is scarcely brought into sufficient prominence. It may, however, be doubted whether Mr. Newlands receives the full share of credit justly due to him as the proposer of the periodic classification.

The authors' remarks on structural formulæ will commend themselves to the judicious chemist. They say—"Structural formulæ are the most developed forms of chemical language · they express much, but not all: of them it may emphatically be said 'They are wise men's counters, but the money of fools.'"

We find in this book no reference to the thermochemical researches of Berthelot, Thomsen, and others, and to the light which they throw upon chemical interaction.

In the concluding chapter we find an utterance which we cannot unhesitatingly accept, *i.e.*, "Chemistry is the daughter of alchemy." We should rather say that alchemy was a temporary aberration which chemistry underwent at an early stage of its growth. The final sentence is significant:—"Chemists have found the elements, and beneath the elements they have found the atoms, and beneath the atoms they sometimes think they perceive the atoms of the one element of which all the known elements and compounds, it may be, are developed forms."

Every student of Science, not merely those who purpose becoming chemical specialists, will do well to add this volume to his library, and to read it heedfully.

Practical Chemistry: a Course of Laboratory Work. By M. M. Pattison Muir, M.A., Fellow and Prælector in Chemistry of Gonville and Caius College, and Douglas Carnegie, B.A., Demonstrator in Chemistry, and formerly Scholar of Gonville and Caius College, Cambridge. Cambridge: The University Press.

In this book the object of the authors is to teach the leading principles of chemistry by a series of very simple experiments, from the results of which the student can draw certain conclusions. This plan is in many respects preferable to the routine system of taking up the elements one by one and describing their respective properties.

In the first part we find explanations of the differences between chemical and physical changes, between elements and non-elements, between mixtures and compounds, the pupil seeing, not hearing, the answers. The classification of elements, which is given in a similar manner, extends only to the halogens, the groups magnesium zinc cadmium, nitrogen phosphorus arsenic antimony bismuth, and chromium manganese iron. The worn-out division of the elements into metals and non-metals—or metalloids as some writers still persist in calling them—is not brought forward.

The second part deals with the laws of chemical combination, equivalents, combining weights, molecular and atomic weights, &c.

In the third part we find, among other matter, an explanation of the methods of determining the constitutions of compounds.

There are Appendices on experiments suggested in Part I., Tables for qualitative analysis, and useful numerical data. There is an excellent Index, and—a still more satisfactory feature—there is no list of questions given at any examination.

An Almanack for the Year of Our Lord 1888. By Joseph Whitaker, F.S.A. London: 12, Warwick Lane.

This well-known and valued annual goes on its way, presenting year by year more useful matter. In examining it we turn naturally first to the section "Societies and Institutions," which comprises a medley of bodies, scientific, religious, benevolent, and political. We are glad to note that certain societies of the "anti" class—*i.e.*, those organised to abolish and suppress something existing—are not advertised. One organisation, which might be very useful if it were less characterised by "masterly inactivity," is omitted,—the "Society for the Advancement of Medicine by Research," 19 Savile Row, W.

We do not find any mention of the Royal Society of Edinburgh, the Royal Irish Academy, nor of the leading provincial scientific bodies.

In examining other portions of this work we come upon certain facts which to us at least appear highly unsatisfactory. We note that the funds at the disposal of the Natural History Department of the British Museum are only £43,000 yearly. If we turn to the particulars given concerning the institutions of higher education we see that Science is very far from occupying a fair position. In almost every case literature and especially classics occupy the leading position. In many public schools there appears to be no professor or master for any branch of physical or natural science. In one school we see that there are *fourteen* "assistant classical masters," whilst for Science—apparently the entire range from astronomy to biology—there is but one. The friends of Science who wish to see this country at least equal any Continental nation in research and discovery have still an arduous task before them.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 21, November 21, 1887.

On the Crystalline Form of Cinchonamine.— C. Friedel.—The crystals deposited on cooling an alcoholic solution appear in hexagonal prisms ending in a rhombohedran.

On a Simple Relation among the Wave-lengths of Spectra.—A. E. Nordenskiöld.—Some years ago the author discovered a simple mathematical relation among the wave-lengths of the spectra of the different elements, that is, in these spectra the differences among the logarithms of the wave-lengths for each element are often simple multiples of the same number. The author was unable, at the time, to conclude these researches, especially as the extreme abundance of rays, which distinguishes the spectra of most of the elements, render

them unfit for solving the question. It appeared that the spectra of the rare earths, on account of their sufficient number of rays for the most part at convenient distances, were peculiarly suited for examining if there existed a mathematical relation analogous to that which the author believes he has discovered among the rays of the spark spectra of different elements, and if this ratio depended on a natural law, or merely on an apparent coincidence between the figures calculated and those observed. The forty absorption rays which MM. Krüss and Nilson represent in their memoir on the absorption-spectra of the rare earths may be divided into two groups, each presenting the fact that the differences of the logarithms of the wave-lengths are simple multiples of one and the same number, or, what amounts to the same thing, the wave lengths of the different absorption rays may be expressed by the formula $\lambda = a^n k$. Here a and k are for each group characteristic constants, and n is a whole number.

On a Blue Derivative of Morphine.—P. Chastaing and E. Barillot.—In a former memoir the authors have shown the formation of derivatives of morphine, produced by the action of oxalic, malonic, and succinic acids upon morphine in presence of sulphuric acid. From these derivatives there is formed, by means of limited oxidation, a blue product, which the authors name morphine blue. Analogous compounds are formed if codeine is substituted for morphine. To obtain morphine blue one of the above derivatives is dissolved in caustic potash and the mixture is exposed to the air or is treated with a current of air. In a couple of days, when the liquid no longer absorbs carbonic acid, there is added a slight excess of hydrochloric acid, when blue flocks are precipitated, which are collected, washed, dried in a vacuum, and when dry exhausted with boiling chloroform. Blue crystals are formed on its spontaneous evaporation. The formula of morphine blue, dried at 120° to 125°, is $C_{26}H_{22}N_2O_4$. The formation of this colour is an extremely delicate reaction for detecting traces of morphine, even in presence of other organic matter.

On a Butylenic Base, and on the Characters of a Class of Diamines.—Albert Colson.—The base in question is formed as follows:—10 grms. isobutylenic bibromide (boiling at 147° to 149°), dissolved in 40 c.c. of aniline, are boiled for ten minutes; the excess of aniline is expelled by distillation in a vacuum; the aniline hydrobromide is removed by washing in cold water, when there remains a viscid matter, insoluble in water, consisting of the butylenic base contaminated with aniline. A secondary aromatic diamine with an ethylenic grouping is distinguished from the primary amines (such as aniline, oluidine, &c.) by its not acting upon phthaleine, whilst ts basic character is shown by methyl-orange. As the molecular weight augments the basic character diminishes.

On the Speed of the Formation of the Ethers.—N. Menschutkine.—The author's conclusions are:—Among all the alcohols the methylic alcohol has the highest constant of speed. The constants of speed differ according to the isomerism of the alcohols; other things being equal the highest constants belong to the primary alcohols (48 to 16), then to the secondary alcohols (14 to 6); those of the tertiaries are very small. In each of these classes the constants of speed vary according to the isomerism of their hydrocarbon radicles. In the series of homologous alcohols of analogous structure the increase of molecular weight reduces the constant of speed. The homologic decrease of the constant is greatest in the series of normal primary alcohols. The series of non-saturated alcohols have lower constants than saturated alcohols containing the same proportion of atoms of carbon.

The Production of Peptone by a Chemical Reaction.—A. Clermont.—The author has succeeded in obtaining the purely alimentary peptonea and syntonine by a simple chemical reaction.

Bulletin de la Société Chimique de Paris.
Vol. xlviii., No. 1, July 5, 1887.

Action of Triethylamine upon α-Bromo-butyric Acid.—E. Duvillier.—Whether the triethylamine is dry or moist the principal product of its reaction upon α-bromo-butyric acid is α-oxybutyric acid, no betaine being formed. If the triethylamine is dry there is formed a trace of tetra-ethyl-ammonium hydrate, and doubtless also a trace of crotonic acid.

On the Bacterian and Physiological Alkaloids: Ptomaines and Leucomaines.—Armand Gautier.—The greater portion of the matter contained in this memoir has already been noticed under a separate work of the author's. He remarks, however, that the ptomaines and the leucomaines are not the sole poisonous substances produced in the living organism. Along with them there exist non-alkaline extractive substances, still more formidable, probably forming the principal and the most active part of the poison of serpents.

Function and Derivatives of Cyan-aceto-phenone.—Alb. Haller.—Cyan-aceto-phenone is met with in the form of white needles, soluble in boiling water, alcohol, and ether; sparingly soluble in petroleum ether and cold water. It melts at 85·5°. The author examines the behaviour of this substance with hydrochloric acid in an alcoholic solution.

On Cyan-acetic Ether.—Alb. Haller.—The author examines whether cyanacetic ether, which contains a methylene group, comprised between CN and $CO_2C_2H_3$, is not capable of having its hydrogen substituted by a metal. He has obtained a sodium compound, from which other metallic compounds, such as those of silver, copper, and zinc, have been obtained by double decomposition.

The Hydrates of Barium Chloride.—H. Lescœur.—The author has obtained two definite hydrates, the ordinary hydrate and the monohydrate, the latter of which is not mentioned in the text-books.

The Derivatives of Erythrene.—Edouard Grimaux and C. Cloëz.—The authors are engaged with the study of erythrene tetrabromide, isobromide, and dibromide, and their derivatives.

Action of Sulphuric Acid upon the Higher Chloro-Benzines.—M. Istrati.—In examining the sulphonic derivatives of tetra-chloro- and penta-chloro- benzine, the author obtains a compound which he names *franceine*, which will be the head of a series of colouring-matters now under examination. This colouring-matter possesses tinctorial powers much more intense than an alcoholic solution of eosine. A solution at 1-500th agrees in colouring power with a one per cent solution of eosine. If applied to the colouration of histological preparations it seems to combine the elective powers of eosine and hæmatoxyline.

On Certain Nitro-derivatives of the Chlorised Ethylbenzenes.—M. Istrati.—In operating upon the ethylated derivative of para-dichloro-benzene the author has obtained two compounds, which he has not named. The second seems to be a mixture of two isomers.

The Hydration of Diallyl.—A. Béhal.—This memoir does not admit of useful abstraction.

Action of Alumina and Kaolin upon Calcium Chloride.—A. Gorgen.—Calcium chloride, if mixed with alumina, kaolin, or common clay, and melted at cherry-redness in presence of moist air, is gradually transformed into certain crystalline bodies soluble in dilute acids. For the present the author merely points out the existence of these bodies without entering into their composition.

Derivatives of Erythrite and of Compressed Gas (Coal-Gas).—Albert Colson.—M. Henninger has already connected erythrene with the crotonylene extracted by Caventon from compressed gas. The author has examined the erythrene hexa-bromides, nitro-bromo-azotine, and the butylenes of compressed gas. The portion of this passing

over at 148° is isobutylene bromide; the second portion consists of diethylidene bromides, and the third agrees in its boiling-point with ethyl-vinyl bromide, found by M. Lebel in the oils of Boghead mineral.

On Carotine.—M. Arnaud.—The author speaks of the properties of carotine, of the precautions to be taken in its extraction, and of its occurrence in various plants, the nettle being the richest in this colouring-matter.

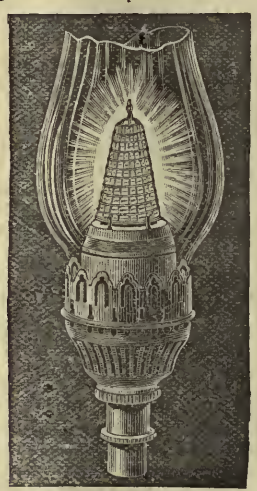
On Novel Chloro-derivatives of Anisol. — L. Hugounenq.—The author has obtained a number of new compounds, which are still under examination.

MISCELLANEOUS.

Royal Institution of Great Britain.—The following Lectures on "Astronomy," adapted to a juvenile auditory, will be given by Sir Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland, at 3 p.m.:—Tuesday, December 27, The Sun; Thursday, December 29, The Moon; Saturday, December 31, The Small Planets.

Diaries for 1888.—We have received a few specimens of Letts's Diaries, published by Cassell and Co., and can recommend them as being quite up to the usual high standard which we are accustomed to look for in works published by this firm.

The Clamond Incandescent Gas-Light. — This light is one of the most formidable rivals to the electric incandescence-burner which has yet appeared in the field. Its construction may be seen from the accompanying cut. Not a few eminent authorities—some of whom, however, seem to be or to have been officially interested in gas—report most favourably upon its efficacy. It is pronounced to be barely distinguishable from the electric light, requiring no motive power and no outlay beyond



the cost of the burners, which can be adjusted to any gas-fittings. The light is said to be steady, bright, and white, and the combustion practically perfect, no damage being occasioned to ceilings, &c., by the deposition of carbon. We find, however, no reference to the generation of sulphurous acid, which, after all, is the greatest objection to gas. The only two burners mentioned in the circulars of the Æolus Water-spray Ventilating Company, the sole agents for this invention, are much too large for use in the generality of private houses, but we presume burners of 8, 10, &c., candle-power are also made.

Preparation of Allyl Iodide; Formation of Allylic Alcohol.—A. Béhal.—The author, after criticising the processes at present in use, proposes a modification of the method of MM. Berthelot and de Luca. He introduces into a tubulated retort holding about 4 litres 2000 grms. glycerin, 60 grms. iodine, and 200 grms. red phosphorus. After stirring well he adapts a refrigerator to the retort and fits a bromine apparatus to the tubulure. He dissolves 440 grms. of iodine in the allyl iodide of a former operation, or dissolves it gradually in the first portions of allyl iodide which pass over, a process which is attended with liberation of heat. The retort is heated over an open fire until the reaction begins and the mass froths strongly. The fire is then regulated so as to maintain a gentle boil and the solution of iodine is let fall in by drops. The allyl iodide passes over slightly coloured by iodine, but when all the iodine has been added it may be obtained colourless by re-distilling. When the operation is completed a very gentle fire is kept up under the retort, and there passes over an aqueous liquid and a certain quantity of allyl iodide. This aqueous liquid contains a large proportion of allylic alcohol.—*Bull. de la Soc. Chimique*, Vol. xlvii., No. 11.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Analyses of Paints.—I wish to know where I will find information as to the analyses of mixed paints.—R.S.

Etching Ink.—Can any reader inform me whether he knows of a method of making a "printing ink" (etching) which is not affected by a weak solution of nitric acid, say one in twenty?—J.H.B.

India-Rubber Cuttings.—Will any reader kindly give me some information as to dissolving or otherwise treating india-rubber cuttings so that they may be readily cast into moulds?—Frank Jordan.

CORTIN'S New Patent NON-ROTATIVE ACID VALVE. For use with Acids or other Corrosive Fluids, Exhaust Gases, &c. This Valve has been universally adopted by the leading Chemical Firms throughout Great Britain, and is pronounced by the most competent authorities to be the only perfect and practical Valve yet invented. Many hundreds now in use. One Valve will last longer than the combined lives of a large number of Cocks or other ordinary means. Entire satisfaction guaranteed. Highest testimonials. Price lists, illustrations, or sample on application — J. CORTIN, Chemical Plant Manufacturer, Newcastle-on-Tyne.

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THE CHEMICAL NEWS.

VOL. LVI No. 1466.

NOTE ON A

SPECIMEN OF GOLD QUARTZ FROM THE TRANSVAAL.

By PHILIP HOLLAND, F.C.S., Public Analyst for Southport.

A SHORT time since I received from a friend a small piece of auriferous quartz. It came from the famous Sheba Reef in the Republic of the Transvaal, and was one of several fragments collected and brought home by a gentleman who had visited the spot in 1886.

I may just mention that the Sheba Hill is distant some 15 miles or so from Barberton, a town that takes its name from two brothers Barber, who found gold in the immediate neighbourhood about two years ago. Prior to the discovery of gold the site of Barberton was probably little more than a topographical expression. In the short space of two years, however, quite a large town has sprung into existence, and has become the important centre and head quarters of a large mixed mining population, numbering, it is said, with those who cater for it, over 4000 people.

Short accounts of the search for gold, and the way in which the mining is conducted, have from time to time appeared in the daily press, but perhaps the most important additions to the general literature of the subject are to be found in a letter from a Cape correspondent to *The Times* of September 23rd, 1886, and in the chatty article contributed by Mr. G. J. Nathan to the current number of *Longman's Magazine*.

My specimen of quartz came, I understand, from the Sheba Hill, which, according to *The Times* letter, is but one of several extensive properties owned by "The Sheba Reef Gold Mining Company." It weighed 18 grms., and was in the form of a splinter or chip, broader at one end than the other. At the broad end was a fissure, about a millimetre wide, stained with ferric oxide, whilst near by and along the line of the fissure gold was distinctly visible without a lens, but could not be seen on any other part of the specimen.

The rock is of a greenish grey colour, and would be described as dark-coloured massive quartz. It differs in general appearance from other Transvaal specimens sent me from Natal, but not yet examined,—one being a lighter quartz than Sheba Hill, with, however, a band of a darker variety more akin to the above running along one face of it; and another a conglomerate consisting of large rounded quartz pebbles, imbedded in a hard red matrix, and said to be rich.

To return, however, to the Sheba Hill sample. I first removed the portion containing the visible gold, setting it aside for special tests; and before powdering the rest for analysis, I carefully overhauled several of the fragments with a lens, which revealed very minute specks of gold, or what then appeared to be gold, on some of them. That the bright yellow particles seen with the lens must not all be assumed to be gold was at once evident on heating some of the powdered rock in an open tube, when SO_2 came off. The rock then contains pyrites probably, and much gold certainly, for on testing a portion of the roasted powder by Skey's method a very distinct reaction was got from a quantity not exceeding 0·17 grm., the whole operation being complete in half an hour. There is a sweet simplicity about this plan of finding small amounts of gold which should, I think, recommend it to prospectors, most of whom will probably have sufficient skill to apply it intelligently.

The examination, then, of the quartz so ar shows that what presumably is pyrites is associated with the gold, and the question naturally suggests itself—How much of the gold is locked up in the pyrites, and therefore not extractable by mercury? This question is one the small amount of material I had does not enable me to answer, but I may state that I am informed in a letter from Natal that the waste from the amalgamators of some companies is said to contain as much as 8 ounces of gold per ton My correspondent, who considers the statement should be received with caution, remarks at the same time that the report has a solid kernel of fact, based on dry assays of the waste made by the chemist to the Transvaal Government. Auriferous mercury is probably present in this waste; should it, however, be as gold-laden as report makes out, there would appear to be "a potentiality of becoming rich beyond the dreams of avarice" for the man who is lucky enough to hit on a cheap and effective plan of extracting the waste on the spot. I am not aware if anything is at present being done in this direction. It would seem the heavy cost of transport bars the way to the importation of chemicals. Some of the original material is being treated in England I hear,—that is to say, the pyritous gold quartz,—but I am not told from what part of the Transvaal it was taken.

When analysing the Sheba Hill specimen I should remark that my object has not been so much to find the amount of gold in it as to learn something of the character of the rock itself,—that is to say, to learn with what rock-forming minerals the gold is associated. To this end sections have been cut by Mr. Norman, of the City Road, which my friend Mr. F. Rutley has kindly examined. He says of them—"The quartz appears to be an ordinary example of vein quartz, the constituent crystals exhibiting irregular boundaries, the structure being what Rosenbusch terms 'allotriomorphous.' The patches in the section which I take to be felspar are not easy to recognise as such. There is also some matter present apparently of a micaceous character." (Small specks of mica were to be seen on the specimens before it was broken up.—P. H.) "This may be muscovite or paragonite. The opaque mineral appears to be partly in irregularly-shaped grains and cubes, partly in forms which give a six-sided outline such as a pentagonal dodecahedron might yield. I think these cubes are pyrites, for I have compared them with gold, first, in a Californian specimen with a ground surface, on which, as I expected, the scoring of the slitting disc was distinctly visible; and again with a small pellet of Californian gold, which I flattened and ground with emery flour. In the latter case the scoring of the emery was very marked. The colour of the crystals in the Sheba quartz is also different from that of undoubted gold. They show, moreover, *no* scoring on their surfaces. I have little doubt that these crystals are pyrites. In your section there are a very few extremely minute opaque crystals, apparently in some cases octahedra, which by surface illumination reflect the light brilliantly on rotating the stage of the microscope. These I think may be gold, for although such brilliant reflection is not usually given by the faces of gold crystals of moderate dimensions, yet it may be seen in certain minute crystallisations, as in some gold specimens from Transylvania and in gold which has been crystallised by fusion with bismuth, the latter metal being subsequently dissolved out with nitric acid. There are numerous fluid lacunæ in the quartz."

As regards the chemical analysis it may be sufficient to say that the bases Al_2O_3, Fe_2O_3, and MgO were brought into solution by treating the very finely powdered sample with re-distilled solution of HF, the usual plan of operations when using this acid being followed. I should observe, parenthetically, that re-distilled solution of HF is not the article sold as such, but acid specially prepared in an apparatus with a condensing arrangement of platinum. Some fluoric acid, by accident or design, contains much H_2SO_4 and SO_2, and is not well suited for the analyses of silicates. I weighed out 2 grms. of the

quartz, making up the final solution, from which all SiF_4 and excess of vitriol had been removed, to the volume of 500 c.c. In this the estimation of the bases above mentioned was duplicated. I may state that a little carbon was observed in this quartz, as was the case in the Nill's Hill quartzite of which I gave an account some months ago.*

Potash being detected spectroscopically, this base and soda were determined on 1 grm. of material by Dr. L. Smith's plan. Lithia was absent. The SiO_2 and combined water were directly determined. For the gold 10 grms. were digested with nitro-hydrochloric acid; the liquid was diluted somewhat, allowed to settle, and filtered. The filtrate and further washings, which were not quite clear, were collected in a dish and evaporated twice to dryness with addition of HCl. The residue, still containing finely suspended siliceous matter, was next taken up with HCl, the whole transferred to a platinum dish, and treated with solution of HF to remove all SiO_2. When the SiF_4 had gone off, it only then remained to bring the residue again into solution, to filter, and to precipitate the gold by an acid solution of ferrous sulphate. At the end of forty-eight hours the supernatant fluid from this operation was passed through a small filter, and the latter—after washing with warm dilute HCl—was reserved pending the re-solution and re-precipitation of the gold which was finally collected upon it. The weight of gold so obtained was 2·9 m.grms from 10 grms. of material, equal to 9 ozs. 9 dwts. 11½ grs. per ton.

I am unable to speak with confidence as to the presence of silver in my specimen of quartz.

The following are the numbers for the full analysis:—

SiO_2	92·860
Al_2O_3	2·860
Fe_2O_3	1·220
FeS_2	0·266
Au	0·029
MnO	—
CaO	—
MgO	0·180
K_2O	1·398
Na_2O	0·411
Combined water	0·580
	99·804

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending November 30th, 1887.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, December 7th, 1887.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from November 1st to November 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 182 samples examined were clear, bright, and well filtered.

Save on the occurrence of exceptional floods, the variations in the character of the river-water supplied to London are, for the most part, very limited in range. Within the range, however, some variation usually makes itself manifest with the coming on of the month of November, and accordingly a slight variation in the composition and character of the water, as prevailing with great uniformity during the previous four months, was recognisable in last month's supply. Thus the mean proportion of organic carbon in the Thames-derived supply was found to be 0·145 part, with a maximum in any one sample examined of 0·166 part in 100,000 parts of the water, as against a mean of 0·137 part, and a maximum of 0·169 part in the preceding four months' supply, the variation, it is observable, being very insignificant.

Similarly as regards the colour-tint of the water—almost always too small to be appreciable by ordinary observation, but capable of being measured by suitable instruments—it is noticeable that while the mean ratio of brown to blue tint in the Thames-derived supply during the preceding four months was found to be as 4·6 to 20, the ratio during the month of November was found to be as 6·5 to 20.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

* I have not as yet found carbon in granite, which is perhaps surprising, since this formation is largely made up of quartz.

REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.*

(Concluded from p. 267).

Appendix.

[A.] *List of Indexes to Chemical Literature.*

(1) *Uranium*, Index to the Literature of. By H. Carrington Bolton. Annals of the New York Lyceum of Natural History, Vol. IX., February, 1870. 15 pp. 8vo.

(2) *Outlines of a Bibliography of the History of Chemistry*. By H. Carrington Bolton. Annals Lyceum Nat. Hist., Vol. X., pp. 352—361. New York, 1873.

(3) *Manganese*, Index to the Literature of; 1596—1874. By H. Carrington Bolton. Annals of the Lyceum of Natural History, New York, Vol. XI., November, 1875. 44 pp. 8vo.

(4) *Titanium*, Index to the Literature of; 1783—1876. By Edw. J. Hallock. Annals of the N. Y. Academy of Sciences, Vol. I., Nos. 2 and 3, 1877. 22 pp. 8vo.

(5) *Vanadium*, Index to the Literature of. By G. Jewett Rockwell. Annals of the N. Y. Academy of Sciences, Vol. I., No. 5, 1877. 13 pp. 8vo.

(6) *Ozone*, Index to the Literature of; 1875—1879. By Albert R. Leeds. Annals of the N. Y. Academy of Sciences, Vol. I., No. 12, 1880. 32 pp. 8vo.

(7) *Peroxide of Hydrogen*, The Literature of; 1818—1878. By Albert R. Leeds. Annals of the N. Y. Academy of Sciences, Vol. I., No. 13, 1880. 11 pp. 8vo.

(8) *Electrolysis*, Index to the Literature of; 1784—1880. By W. Walter Webb. Annals of N. Y. Academy of Sciences, Vol. II., No. 10, 1882. 40 pp. 8vo.

* *From the Proceedings of the American Association for the Advancement of Science*, Vol. xxxvi.

(9) *Speed of Chemical Reactions*, Literature of. By Robert B. Warder. Proceedings of the Am. Assoc. Adv. Science, Vol. XXXII., 1883. 3 pp. 8vo.

(10) *Starch-sugar*, Bibliography of. By Edw. J. Hallock. Appendix E to report on Glucose prepared by the National Academy of Sciences in response to a request made by the Commissioner of Internal Revenue. U. S. Internal Revenue, Washington, D. C., 1884. 44 pp. 8vo.

(11) *Ozone*, Index to the Literature of, 1879—1883; accompanied by an Historical-Critical Résumé of the Progress of Discovery since 1879. By Albert R. Leeds. Annals N. Y. Academy of Sciences, Vol. III., p. 137, 1884. 16 pp. 8vo.

(12) *Peroxide of Hydrogen*, Index to the Literature of; 1879—1883. By Albert R. Leeds. Annals N. Y. Academy of Sciences, Vol. III., p. 153, 1884. 3 pp. 8vo.

(13) *Dictionary of the Action of Heat upon Certain Metallic Salts*, including an Index to the principal Literature upon the Subject. Compiled and arranged by J. W. Baird, contributed by A. B. Prescott. New York, 1884. 70 pp. 8vo.

(14) *Bibliography of Petroleum*, by Prof. S. F. Peckham. Report on the Production, Technology and Uses of Petroleum and its Products. Report of the tenth census of the United States, Vol. X., 1884, 4to; pp. 281—301. [A comprehensive bibliography of *Bitumen* and its related subjects.]

(15) *A Catalogue of Chemical Periodicals*, by H. Carrington Bolton, Annals N. Y. Academy of Sciences, Vol. III., pp. 159—216. New York, 1885. 8vo. Also Chemical News Print, London, 1886.

(16) *Iridium*, Bibliography of the Metal, by Nelson W. Perry, in Prof. W. L. Dudley's paper on Iridium published in Mineral Resources of the United States, calendar years 1883 and 1884. Washington, 1885. 8vo.

(17) *Uranium*, an Index to the Literature of; 1789-1885. By H. Carrington Bolton. Smithsonian Report for 1885. Washington, 1885. 36 pp. 8vo.

(18) *Explosives*, Index to the Literature of. Part I. By Charles E. Munroe, Baltimore, 1886. 42 pp. 8vo.

(19) *Supplement to a Catalogue of Chemical Periodicals*. By H Carrington Bolton. Annals N. Y. Academy of Sciences, Vol. IV., 1887. 4 pp. 8vo.

(20) *Short Titles of Chemical Periodicals current in* 1887. By H. Carrington Bolton. J. of Analytical Chemistry, Vol. I., Part I., 1887. 4 pp. 8vo.

Note. Copies of 1, 3, 9, 13, 15, 16, 17, 18 and 19 can be obtained by addressing the respective authors. Copies of 2, 4, 5, 6, 7, 8, 11, 12, can be had of Prof. D. S. Martin, New York Academy of Sciences. Copies of 10 can be had of the Commissioner of Internal Revenue. Copies of 14 can be had of the Census Bureau, Washington, D. C.

[B]. *Provisional List of Abbreviations of Titles of Chemical Journals.*

The numbers refer to the Catalogue of Chemical Periodicals by H. Carrington Bolton, New York, 1885, 8vo. Titles 183—196 in the Supplement, New York, 1887 [Nos. 15 and 19 of the preceding list].

1. Afh. Fys. Kemi.
2. Agenda chim.
3. Chem. Ztg.
4. Allg. chem. Bib (Trommsd.)
5. Allg. J. Chem. Scherer
   a N. allg. J. Chem. Gehlen.
   b J. für Chem. Gehlen.
   c J. für Chem. Schweigger.
   d J. prakt. Chem.
6. Alm. di chim. agric.
7. Alm. de chim.
8. Alm. Scheid. Apoth.
   a Taschenb. f. Scheid.
9. Am. Chem. J.
10. Am. Chemist.
11. Am. Lab.
12. Analyst.
13. Ann. Chem. (Liebig).
14. Ann. chim. phys.
15. Ann. di chim. (Brugnatelli).
16. Ann. fis. chim.
17. Ann. Chem. Med.
18. Ann. Chem. Phil.
19. [Refer to 14].
20. Ann. Chym. Pract. Pharm.
21. Ann. Pharm. Bastick.
22. Ann. Phil. (Thomson).
23. Annuaire prod. chim.
24. Annuaire chim.
15. Annuaire sci. chim.
26. Annual Rep. Chem.
27. Anno. alm. pei chim.
28. Anno. chim. ital.
29. Anno. scienze chim. nat.
30. Anno. scienze chim. farm.
31. Anti-Adult. Rev.
32. Arch. der Agr.-Chem.
33. Arch. for Pharm. Trier.
34. Arch. ges. Naturl.
35. Arch. für theor. Chem.
36. Arch. thier. Chem.
37. Arsb. Phys. Chemi.
38. Ausw. Abh. Chem. Crell.
39. Ausw. Ann. Chem. Crell.
40. Beitr. Chem. Wasserberg.
41. Beitr. Min. Klaproth.
42. Beitr. Chem. Bucholz.
43. Arch. für physiol. Chem.
44. Ber. d. chem. Ges. (*or* Ber.)
45. Berl. Jahrb. Pharm.
46. Bibl. phys. Lit. (Hermbstädt). Ann. Chem. Lit.
47. Boston J. Chem.
48. J. de pharm.
49. Bull. math. chim. (Férussac).
50. Casopis chem.
51. Centrbl. Agr.-Chem.
52. Chem. Gaz.
    Chem. News.
53. Chem. News Am. Repr.
54. Chem. Record. (Lond.)
55. Chem. Rev. (Lond.)
56. Am. Chem. Rev.
57. Chem. Kal.
57*a*. Techn.-chem. Jahrb.
58. Chem. Ackersmann.
59. Chem. Ann. Crell.
60. Chem. Ind. (Jacobsen).
61. Chem. phys. oefen.
62. Chem. Archiv Crell.
63. Chem. J. Crell.
64. Chem.-pharm. archief.
65. Chem. techn. Mitthl.
66. Chem. techn. Repert.
67. Chemist. Mongredieu.
68. Chemist. Watt.
69. Chem. and Drug.
70. Chem. Advocate.
71. Chem. and Meteor. J. (Amherst).
72. Chem. Desk Comp.
73. Chemists' J.
74. Chimiste, Bruxelles.
75. Chimiste, Paris.
76. Compt. rend. *or* C. R.
77. C. R. chim. Montpellier.
78. Crell's Chem. J. Lond.
79. Deutscher Chem. Kal.
80. Edinb. J. Sci.
81. Fortschr. techn. Chem.
82. Fortschr. theor. Chem.
83. Fortschr. Chem. Köln.
84. Gazz. chim. ital.
85. Gazz. chim. techn. (Sembenini).
86. Gazz. farm. (Sembenini).
87. Gazz. farm. chim. (Venezia).
88. Giorn. fis-chem. ital.
89. Giorn. chim. veterin.
90. Giorn. farm. chim (Gajani).
91. Giorn. di farm. Chiappero.
92. Giorn. di farm. Cattaneo.
   a Bibl. di farm.
   b Ann. di farm. appl. (Polli).
93. Giorn. di fis. Majocchi.
94. Giorn. di fis. Brugnatelli.
95. Obs. sur. phys.
   a J. de phys.
96. Jahrb. Erfind.
97. Jahrb. ökon. Chem.
98. Jsb. Agr.-chem. (Ditmer).
99. Jsb. rein. Chem.
100. Jsb. Agr. Chem.
101. Jsb. chem. Techn. (*or* Wagner's Jsb.)
102. Jsb. phys. Wiss. (*or* Berzelius' Jsb.)
103. Jsb. Chem.
104. Jsb. thier Chem.
105. J. chim. phys. Van Mons.
106. J. chim. med.
107. J. chim. Van Mons.
108. J. der Pharm. Trommsd.
109. J. der Phys. Gren.
   a N. J. der Phys. Gren.
   b Ann. der Phys. Gren.
   c Ann. der Phys. Gilbert.
   d Ann. der Phys. Pogg.
   e Ann. der Phys. Wied.
   f Beibl. Ann. der Phys.
110. J. Phys. Krönig.
111. J. techn. Chem.
112. J. Appl. Chem.
113. Nicholson's J.
114. J. Soc. Chem. Ind.
115. K. phys. chem. Abh.
116. Ztschr. Chem.
117. Laboratorium.
118. Laboratory, Boston.
119 Laboratory, Lond.
120. Listy chem.
121. Mag. f. Apoth. (Elwert.)
   a Report f. Chem. (Elwert).
122. Mag. höhere Naturw.
123. Mech. and Chem.
124. Mél. phys. chim.
125. Mem. prat. chim.
126. Mem. Columb. Chem. Soc.
127. Misc. chim. fis. (Pisa.)
128. Mitthl. Chem. (Kletzinsky).
129. Mitthl. Lab. Chem Brünn.

130. Monatsh. Chem.
131. Monit. prod. chim.
132. Month. Mag. Pharm.
133. Naturh. chem. Notiz.
134. Mag. für Pharm. (Geiger).
135. Orosi.
136. Penny Mech.
137. Pharm. Times.
a Chem. Times.
138. Pharm. Centrbl.
b Chem. Centrbl.
139. Pharmacist.
140. Phil. Mag.
141. Piria.
142. Proc. Am. Chem. Soc.
a J. Am. Chem. Soc.
143. Proc. Chem. Soc.
a Q. J. Chem. Soc.
b J. Chem. Soc.
144. Raccolta fis. chim.
a Ann. fis. Zantedeschi.
145. [Refer to 37.]
146. Recherches phys. - chim.
147. Recueil trav. chim.
148. Rép. chim. Paris.
149. Rép. chim. pure. Rép. chim. appl. Bull. Soc. chim. (Paris).
150. Rép. de Pharm. Bruxelles.
151. Rép. de Pharm. Paris.
152. Rep. anal. Chem.
153. Rep. chem. Pharm. St. P.
154. Rep. der Pharm. (Buchner).
155. Rep. org. Chem. (Löwig).
156. Rep. Pharm. Russland.
156*A*. Rev. hebd. chim.
157. Rev. Sc. Quesneville.
a Monit. Sc. Quesneville.
158. Rev. ind. chim.
159. Revista chim.
160. Samml. Abh. Chem. Hochheimer.
161. Scheik. bibl.
162. Scheik. bijdr.
163. Scheik. onderzoek.
164. School Mines Q.
165. Taschenb. Scheik.
166. Techn.-chem. Kal.
167. Techn. - chem. Gewerbebl.
168. Techn.-chem. Jahrb.
169. Tekno-kem. J.
170. Tidssk anv. Chemi.
171. Tidssk Phys. Chemi.
172. Tijdsch. wet. pharm.
173. Toeg. scheik.
a Maandbl. toeg. scheik.
174. N. Gegenst. Chem. (Richter.)
175. Unters. Liebig's Lab.
176. Vjschr. techn. Chem.
177. Yearbook Pharm.
178. Ztschr. anal. Chem.
179. Ztschr. chem. Grossgew.
180. Ztschr. physiol Chem.
181. Zhurnal. Khim.
182. Zpravy Chem.
183. Bull. assoc. chim. France.
184. Bull. Chem. Soc. Washington.
185. Chemiker. u. Drogist.
186. Chem. - techn. Centrlanz.
187. Deutsche Chem.-Ztg.
188. J. Anal. Chem.
189. Meddel. Carlsberg Lab.
190. N. Y. Analyst.
a Am. Analyst.
191. Skand. Kem. Centrlblad.
192. Suppl. enciclop. chim.
193. Tokyo K. Kaishi.
194. Vjschr. Chem. Nahr.
195. Ztschr. Chem. Ind.
196. Ztschr. phys. Chem. Am. J. Sci. Arch. sc. phys. Jen. Ztschr. Sitzb. Akad. Berlin. Sitzb. Akad. Wien. Phil. Trans. Lond. Proc. Roy. Soc. Proc. Am. Acad. Ann. N. Y. Acad. Sci. Proc. Acad. Nat. Sci. Phil.

The number of Society Transactions publishing chemical papers is very great, and the list (added at the suggestion of some members of the committee) could be greatly extended.

ANALYSIS OF MICA FROM LEON CO., TEXAS.*

By GEORGE W. LEIGHTON.

This mica, submitted to our examination by Professor Cooke, was received by him from Dr. A. E. Foote, of Philadelphia, who identifies it as the Joakumite of the Texas Academy of Sciences. The mineral attracted notice, as it presented characteristics intermediate between those of the vermiculites and the muscovites, and it was hoped that an analysis might add to our knowledge of the relations between these species.

Description.—The mica is opaque except in thin laminæ, and has obviously undergone alteration. Cleavage basal eminent, laminæ flexible, but brittle and non-elastic Lustre pearly. Colour brownish to yellowish green. Double refraction negative. Biaxial; with bisectrix nearly if not absolutely normal to the cleavage, the optical angle in air measuring about 37½°, but could not be measured accurately on account of opacity. In blowpipe flame the laminæ separate, swelling to more than double the original thickness, and melting on the edges, showing fusibility 5—6. Blowpipe flame strongly coloured with potash, barely tinged with soda, and with traces of lithia. No fluorine could be detected by the usual tests.

The Analysis was made in the usual way, fusing with Na_2CO_3 for the silica, decomposing with HF for the alumina, iron, and magnesia, and by Lawrence Smith's method for the alkalies. The iron was all in the ferric condition, and was determined volumetrically after weighing Al_2O_3 and Fe_2O_3 together. The potash was weighed as chloroplatinate, and the water was determined by ignition. In the following table the results of our analysis are given in Column I. In Column II. are the corresponding per cents of oxygen, and in Column III. are given, for comparison, the results of an analysis of a mica from Hirschburg, taken from Dana's "System of Mineralogy," last edition, and classed by him among the muscovites.

	I.	II.	III.
SiO_2	48·95	26·11	49·04
Al_2O_3	25·17	11·73	29·01
Fe_2O_3	9·40	2·82	5·56
MgO	1·69	0·67	0·75
CaO	trace	—	0·17
Na_2O	trace	—	0·50
K_2O	11·08	1·88	11·19
H_2O	4·31	3·83	4·65
	100·60		100·87

Oxygen Ratios.—Bases with water to silica are as 4 : 5 nearly. Bases without water to silica are as 2 : 3 approximately.

$$RO + H_2O : R_2O_3 : SiO_2 = 5 : 11 : 20.$$
$$RO : R_2O_3 : SiO_2 = 2 : 11 : 20.$$

Conclusions.—Here, then, we have an evident product of alteration, with some of the characters of a vermiculite, which differs in composition from ordinary muscovite mica only in the absence of fluorine, and the presence of a somewhat larger amount of magnesia. Possibly muscovite may pass into vermiculite, and this mica from Texas may represent the first step in the alteration; but if so, intermediate stages must be found, and then this work may help to answer the question. As will be seen, the composition of the Texas mica agrees closely with that of the mica from Hirschburg, the difference in the relative amounts of Al_2O_3 and Fe_2O_3 being unessential.

* *Proceedings of the American Academy of Arts and Sciences.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 15th, 1887.

Mr. William Crookes, F.R.S., President, in the Chair

Messrs. Herbert E. Kirby, John Norman Collie, and Sydney Martineau were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Samuel Banner, Sherwood, Sefton Park, Liverpool; Arthur G. Bloxam, Royal Agricultural College, Cirencester; Lewis Walter Hawkins, 18, Burr Street, London, E.; Stevenson J. C. G. Macadam, Brighton House, Portobello, Edinburgh; Sidney Skinner, B.A.

Christ's College, Cambridge; Charles Francis Townsend, Ashley Road, Epsom; Alfred Edwin Tutton, 12, South Parade, Brompton, S.W.

The following papers were read:—

92. "*An Apparatus for Comparison of Colour-Tints.*" By Alfred W. Stokes.

In operations such as Nesslerising in water analysis, when it is necessary to compare a number of depths of tint with one another, it is very inconvenient to have to make up a large series of standard tints. The author has devised an apparatus which obviates this necessity. It consists of a base-board on which lies a sheet of white opal glass. Placed obliquely a little way above this is a sheet of glass on which rest the Nessler-tubes containing the solutions whose tints are to be compared. The mouth-ends of these tubes recline in grooves hollowed in a horizontal bar. This bar is supported by two pillars, on one of which slides a ring clasping a calibrated glass tube: this tube has a side tubulure at the base, and is thus and by means of a short india-rubber tube connected with a similar but uncalibrated tube resting on the glass plate. A known quantity of the standard colour being placed in the tube carried by the ring and diluted with water up to the top mark, if the movable tube be raised this standard solution will flow into the tube resting on the glass plate. The movable tube is calibrated to show how much is present in the other tube. Hence, if a Nessler-tube containing liquid of unknown depth of tint be placed beside the tube on the glass plate, and the tube in the sliding ring be raised or lowered till the tints agree in the two tubes resting on the glass plate, a simple inspection of the level of the liquid in the calibrated tube will give the quantity of standard colour the unknown solution is equal to.

The apparatus is especially useful in Nesslerising; also in determinations of the quantity of lead present in waters, and in other cases where comparison of tint depths is necessary.

93. "*The Alloys of Copper and Antimony and of Copper and Tin.*" By E. J. Ball, Ph.D.

The author gives the results of experiments instituted with the view of obtaining further evidence as to whether the alloys Cu_2Sb and Cu_4Sb, which are indicated by changes in the direction of the curve by which the electrical conductivity of the copper-antimony alloys is expressed, are or are not compounds. Copper, antimony, and lead were melted together in varying proportions, lead being a metal which alloys only to a very slight extent with copper. Mixtures of Cu_2Sb and lead were first made, the first alloy containing 95 per cent of lead, the second 90 per cent of lead, and so on for the remainder of the series. No alloys could be formed between the one with 20 per cent and that with 65 per cent of Cu_2Sb. The intermediate mixtures that had separated on solidification were all melted up together and allowed to cool slowly, with the result that owing to the partial oxidation and consequent loss of antimony in the successive fusions and castings, the metal was found to have separated on solidification into three alloys of different densities. The upper of these had the composition Cu_4Sb, the alloy which occupies the lowest position on the conductivity curve. The mixture of 75 lead and 25 Cu_2Sb, the first that separated after fusion, when cast in a cylindrical mould, separated on cooling into two concentric cylinders, the inner of which had the same composition as that of the last alloy that formed before the separation of the fused mixture into two alloys, *i. e.*, 80 lead and 20 Cu_2Sb. The author is of opinion that this represents the saturated solution of Cu_2Sb in lead. The alloys were then cast into discs, which were ground to the same size and examined by the aid of the Hughes induction balance. The curve of relative conductivity so obtained was practically a straight line between the terminal points. In view of this fact, and since in their general appearance the alloys resemble both in colour and structure mixtures of Cu_2Sb and lead, it would appear that Cu_2Sb exists in these alloys as such.

In the second series of alloys the first mixture consisted of 95 antimony, 2·5 lead, and 2·5 copper; the second of 90 antimony, 5 lead, and 5 copper. These alloys were all more or less grey in colour, and their fracture became conchoidal as the alloy approached in composition Cu_4Sb. The induction balance curve rose gradually, till the copper and antimony were almost in the proportions necessary to form Cu_2Sb, and then fell again as this point was passed.

In the third series the first alloy formed contained 95 copper, 2·5 lead, and 2·5 antimony; the second contained 90 copper, 5 lead, and 5 of antimony. All the alloys of this series formed, except the one with 50 copper, 25 lead, and 25 antimony: this separated on cooling into an alloy which was again found to have the composition Cu_4Sb and lead containing antimony and copper. The induction balance curve of this series, allowing for the dilution of the copper-antimony alloys by lead, is identical with that of the copper-antimony alloys free from lead. Throughout these three series of alloys the lead appears to be wholly without influence on the physical properties except that which it exercises as a diluent, the influence of the alloys forming the turning-points of the conductivity curve, Cu_2Sb and Cu_4Sb, being as marked in the presence of lead as when that metal is absent. Hence the author believes that these two alloys are true compounds. When they are fused with silver sulphide, the copper in both Cu_2Sb and Cu_4Sb is to a great extent displaced by silver, without greatly altering the character of the alloy.

Copper-tin alloys were treated with lead in a similar manner, and in this case also the lead appeared to be without effect on the general character of the alloys, the influence of the alloys, which are indicated by the turning-points of the conductivity curve, viz., Cu_3Sn and Cu_4Sn, being as marked as in the case of the turning-points of the copper-antimony alloys Cu_2Sb and Cu_4Sb.

Discussion.

Prof. Roberts-Austen said that the alloy of copper and antimony known as the "Regulus of Venus" is the only alloy having an intense violet colour, which made it an object of great interest to the alchemists, but it had been strangely neglected by their successors in modern times. Lead unites readily with antimony, and it therefore appeared not improbable that lead would induce a certain amount of antimony to leave the copper and form triple alloys; but Dr. Ball had shown that the antimony and copper alloys remained intact, and that lead merely diluted them. This was specially interesting because—to turn to other metals—it is well known that zinc and lead, if melted and mixed in the fused state, separate from each other almost entirely on cooling. Notwithstanding this fact, A. and L. Svanberg had shown that in the presence of a third metal—viz., tin—lead and zinc will unite to form a triple alloy, $ZnSn_3+2PbSn_3$, which solidifies at 168° C. It was generally assumed that rapid cooling prevented the "liquation" or separation of the constituents of alloys, but the speaker had shown in the case of the silver-copper alloys that *slow* cooling produced products as uniform in composition as Levol's alloy containing 71·8 per cent of silver, the only alloy of the series which was formerly believed to be uniform in composition.

Prof. Roberts-Austen added that he was glad of the new evidence afforded by the author's observations of the delicacy of the Hughes induction balance, an instrument which he had long since predicted would prove to be of great service in studying the molecular constitution of alloys.

Dr. C. R. Alder Wright said that the determination of the constitution of ternary alloys involved the solution of some very interesting problems, which in certain cases appeared to be of a far more complex order than was generally supposed. A great distinction was to be made between the amount of permanent miscibility possible

with fluid metals whilst kept molten by heat, and the more or less complete segregation taking place during solidification on cooling, especially when slowly effected. In the latter case the separation appeared frequently to be regulated by the formation of alloys of definite constant compositions, atomic or otherwise, which possessed fusing-points higher or lower than those of the rest of the masses; so that one portion solidified first, leaving, so to speak, a more fusible mother-liquor. But it was quite different in the former case: with certain metals in certain proportions the mixture when melted, well stirred together and then left quiescent for some time in a molten condition, separated into two layers, just as a mixture of ether and water, or certain mixtures of ether, alcohol, and water would do if shaken up and then allowed to stand: the relative proportions in which the metals divided themselves were doubtless regulated by some law, because one given mass always divided itself in one way, and another in another, and so on; but this law or guiding principle did not seem to be connected with combination in atomic proportions, nor upon the production of any one particular alloy which formed and separated from the rest of the mass. He was not in a position at present to indicate what really was the guiding principle in such cases, but hoped that some experiments upon which he and Mr. C. Thompson were now engaged would throw light on the question. These experiments were being carried out with various mixtures of lead, zinc, and tin or bismuth: thus, for example, a series of ingots were made by mixing equal weights of lead and zinc in each case with varying amounts of tin, melting together, well stirring and keeping molten for one to two hours, and then cooling without more delay than was absolutely necessary in order to diminish possible sources of error through incipient segregation during solidification taking plare in either the bottom or the top one of the two layers into which the molten mass divided itself during the period of quiescence. The top and bottom portions being analysed and the lead and tin calculated per unit of zinc in the first case, and the zinc and tin per unit of lead in the second, and these pairs of values being plotted off as abscissæ and ordinates respectively, curves were obtainable from comparison of which he hoped to be able to deduce the guiding principle. In each case the amount of zinc taken up by the heavier alloy in which lead predominated, and that of lead in the lighter alloy in which zinc predominated, increased with the amount of tin present, but not always in the same ratio. Moreover, the relative proportions in which the tin divided itself between the bottom and top layers was not constant, but varied with the proportion of tin in the total mass; so that the production of atomic compounds of the metals, even if it occurred at all, was certainly not the sole explanation of the results. The principle of two saturated solutions being formed also appeared to be inapplicable.

In answer to a further question by Dr. Ball, Dr. Alder Wright said that his experiments were as yet hardly complete enough to enable him to pronounce definitely, but he thought that the formation of an eutectic alloy would not afford an adequate explanation, because, if this were the case, either the top or the bottom layer (presumably the latter, being usually the more fusible) should exhibit constancy of composition which was very far from being the case; the principle of eutexia no doubt largely regulated the solidification of molten masses on cooling; but it did not seem to be so closely connected with the miscibility of molten metals kept fluid throughout. As regards avoiding loss by oxidation during fusion and volatilisation of zinc, he had found that a little cyanide of potassium previously fused in the melting-pot largely if not entirely prevented both sources of alteration, and was preferable for this purpose to borax or metaphosphate of soda, &c., as these substances did not exert any reducing action, but simply cleansed the metal by dissolving any oxide that might be formed.

94. "*The Constitution of the so-called Mixed Azo-Compounds.*" By Francis R. Japp, F.R.S., and Felix Klingemann, Ph.D.

The authors find that diazobenzene chloride interacts with ethylic sodiomethacetoacetate to form acetic acid and an ethereal salt, $C_{11}H_{14}N_2O_2$ (m.p. 117°), which by hydrolysis is converted into the acid $C_9H_{10}N_2O_2$ (m.p. 185°). They have also prepared homologues of these compounds, substituting ortho- and para-diazotoluene for diazobenzene, and ethylic ethacetoacetate for methacetoacetate. They at first regarded the acid $C_9H_{10}N_2O_2$ as benzene-azo-propionic acid, $C_6H_5\cdot N_2\cdot CH(CH_3)\cdot COOH$ (see *Ber.*, xx., 2942). It yields on reduction a hydrazo-acid, $C_9H_{10}N_2O_2$ (m.p. 170°), which proved to be the *α*-phenylhydrazidopropionic acid of Fischer and Jourdan, obtained by reduction of phenylhydrazinepyruvic acid. On comparing the supposed benzene-azo-propionic acid with phenylhydrazinepyruvic acid, it was found that the two compounds were identical, the melting-point (169°) given by Fischer and Jourdan being much too low. It therefore appeared probable that the acid was a hydrazide: this view is supported by the following proof that "benzene-azo acetone," hitherto formulated—

$$CH_3\cdot CO\cdot CH_2\cdot N_2\cdot C_6H_6,$$

is in reality a hydrazide of the formula—

$$CH_3\cdot CO\cdot CH : N\cdot NHC_6H_5,$$

derivable from pyruvic aldehyde.

By acting on "benzene-azo-acetone" with sodium ethoxide and ethylic chloracetate, an ethereal salt was obtained which on hydrolysis yielded an acid of the formula $C_{11}H_{12}N_2O_3$ (m.p. 161° to 162°). By reduction this acid gave anilido-acetic acid, but no aniline, thus proving that it has the formula—

$$CH_3\cdot CO\,CH : N\cdot N(C_6H_5)CH_2\cdot COOH.$$

If "benzene-azo-acetone" had the formula hitherto ascribed to it, the introduction of $CH_2\cdot COOH$ into the methylene-group would have occurred and the resulting compound would have yielded aniline on reduction.

The above view is confirmed by the fact that the phenylhydrazide of "benzene-azo-acetone" proves to be identical with the dihydrazide—

$$C_6H_5NH\cdot N : CH\cdot C(CH_3) : N\cdot NHC_6H_5,$$

recently obtained by Von Pechmann from methylglyoxal (pyruvic aldehyde) and phenylhydrazine.

The authors therefore regard the various so-called mixed azo-compounds obtained by the action of diazo-salts upon compounds of the ethylic acetoacetate type, as hydrazides. They point to the parallel case of the formation of isonitroso-compounds (hydroximes) by the action of nitrous acid, and suggest that this analogy would be more perfect if *free* diazobenzene were regarded as the anilide of nitrous acid thus: $ON\cdot NHC_6H_5$. Experiments are being undertaken in support of this view. They had intended to study the action of reducing agents on the alkyl-derivatives of the benzene-azo naphthols in order to settle the question, already mooted by Zincke, as to whether the latter are azo-compounds or hydrazides; but have renounced this intention on learning that Prof. Meldola is engaged in investigating this subject.

95. "*The Interpretation of Absorption Spectra.*" By G. H. Bailey.

96. "*The Reduction of Potassium Bichromate by Oxalic Acid.*" By C. H. Bothamley, Assistant Lecturer on Chemistry, Yorkshire College.

Potassium bichromate and hydrated oxalic acid, finely powdered and intimately mixed, interact spontaneously after two or three hours, or instantly if heated to 30° to 35°; after heating at 110° to 120° until the weight is constant, a dark friable residue is obtained which is completely soluble in water. If the mixture which has been heated at 110° to 120° is heated over a low flame, care being taken to avoid fusion, further decomposition ensues, and on treatment with water chromic oxide remains un-

dissolved and a solution of potassium chromate free from oxalic acid and chromic salts is left.

If dehydrated oxalic acid be taken the interaction does not take place spontaneously, but occurs instantly at 30° to 35°, the product being a very bulky porous and friable grey solid; the nature and limit of the interaction is, however, the same as with the hydrated acid.

With an excess of oxalic acid reduction is complete, but with excess of bichromate the interaction is different. The first stage of the interaction, which takes place at a temperature not exceeding 120°, is represented by the equation—

$$2K_2Cr_2O_7+6H_2C_2O_4=Cr_2(C_2O_4)_3+6H_2O+6CO_2+2K_2CrO_4.$$

The decomposition is limited, even in presence of excess of bichromate, by the formation of chromic oxalate, which is not further oxidised at 120°. At a higher temperature in presence of only a slight excess of bichromate the chromic oxalate decomposes in accordance with the equation $Cr_2(C_2O_4)_3=Cr_2O_3+3CO+3CO_2$. If, however, a considerable excess of bichromate is present further oxidation takes place thus :—

$$2K_2Cr_2O_7+Cr_2(C_2O_4)_3=2Cr_2O_3+6CO_2+2K_2CrO_4.$$

The complete oxidation of oxalic acid in presence of a large excess of potassium bichromate is represented by the equation—

$$4K_2Cr_2O_7+6H_2C_2O_4=2Cr_2O_3+4K_2CrO_4+6H_2O+12CO_2.$$

97. "*The Reduction of Chlorates by the Zinc-Copper Couple.*" By C. H. BOTHAMLEY and G. R. THOMPSON.

When a solution of potassium chlorate is reduced by means of the zinc-copper couple (Thorpe, *Trans.*, 1873, 541) a portion of the reduced chloride is converted into zinc oxychloride, which is insoluble in water but readily soluble in dilute sulphuric acid. The quantity of oxychloride formed is greater the more concentrated the solution. In order to avoid the error due to this cause the chlorate solution is heated with the couple for about one hour, and pure dilute sulphuric acid is then added until the zinc hydroxide and oxychloride just dissolve. The liquid is filtered, neutralised with calcium carbonate, and titrated with silver nitrate. Thus modified, the method gives very accurate results; the solution should not contain more than 1·5 grms. of potassium chlorate in 25 c.c., and should just cover the couple.

98. "*Preliminary Notice on the Oxidation of Oxalic Acid by Potassium Dichromate.*" By EMIL A. WERNER, Assistant in the Chemical Laboratory, University of Dublin.

In the course of an investigation of chromoxalates and analogous chromium compounds with other organic acids, ths results of which have already been partly published (*Trans.*, 1887, 383), I was led to study the action of oxalic acid on potassium dichromate solutions in presence of sulphuric acid. The results already obtained seem noteworthy, and in view of the fact that a paper on the same or a similar subject is announced, I send the following short note :—

In the preparation of the blue chromoxalates already described, 9 mols. of oxalic acid are required for the complete reduction of each molecule of potassium dichromate; in this interaction the oxalic acid is divisible into two distinct portions, viz., 3 mols. which are used ap in the reduction of the dichromate, and 6 mols. which combine with the reduced chromium to produce the chromoxalate : *e. g.*,—

$$2KCr_2O_7+6H_2C_2O_4+3H_2C_2O_4=K_2H_4Cr_2(C_2O_4)_6+7H_2O+6CO_2.$$

I have endeavoured to use instead of the persistent 6 mols. oxalic acid their equivalent of succinic acid, but I find that the interaction proceeded in an entirely different manner; only a *partial reduction* of the dichromate is effected by the 3 *mols.* of oxalic acid, and no compound whatever of chromium and succinic acid is produced, the final products of the reaction being—(1), the red chromoxalate of Crofts, $K_2Cr_2(C_2O_4)_4$; and (2), free $K_2Cr_2O_7$ (about two-fifths of the original amount), the succinic acid remaining unaltered.

If oxalic acid be added until the dichromate is all reduced, 9 *mols. are required*, and the interaction proceeds exactly as in the absence of the succinic acid. An attempt to effect a partial replacement of the oxalic by succinic acid was attended with the same result.

From these results I was led to investigate more closely the oxidation of potassium dichromate by oxalic acid in presence of sulphuric acid, and while looking over the literature of the subject I was struck by the following account of the method of preparing chrome-alum in "Watts's Dictionary" (3rd Supplement). In the preparation of chrome-alum by the action of sulphuric acid on potassium dichromate, the reduction of the latter may be conveniently effected by oxalic acid, when it is not necessary to add an excess of the reagent, as the reaction is complete when CO_2 ceases to be evolved, &c. The equation representing the change is as follows :—

$$K_2Cr_2O_7+4H_2SO_4+3H_2C_2O_4=K_2Cr_2(SO_4)_4+6CO_2+7H_2O.$$

29·5 parts of dichromate are dissolved in 39 parts of sulphuric acid and the necessary amount of water, and 38 parts of oxalic acid added gradually in small portions (Lielegg, *Dingl. Polyt. J.*, ccvii., 321). The production of chrome-alum by this method is entirely dependent on the "necessary amount of water," the above equation being only true when little or no water is present, dilution of the mixture causing only partial reduction of the dichromate, with production of varying amounts of red chromoxalate and chromium sulphate, the former increasing and the latter diminishing with the degree of dilution, and *vice versâ*. I am at present engaged in investigating this reaction in all its details, with special reference to the influence of mass and temperature.

The remarkable affinity existing between chromium and oxalic acid as shown in these reactions, becomes all the more interesting when compared with the not less remarkable inert behaviour of chromium towards succinic acid. All attempts hitherto to obtain compounds corresponding to the chromoxalate containing succinic acid have been unsuccessful; in fact *freshly* precipitated chromic hydroxide is perfectly insoluble in excess of succinic acid solution at the boiling temperature, and when heated in sealed tubes at 120° to 130° C. only a mere trace of the chromium enters into solution.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 18th, 1887.

Professor BALFOUR STEWART, LL.D., F.R.S., President, in the Chair.

"*On the Possible Equations expressing the Decomposition of Potassic Chlorate by Heat.*" By JAMES BOTTOMLEY, D.Sc., B.A., F.C.S.

It has long been known that potassic chlorate, when heated, is resolved into oxygen, potassium chloride, and a more highly oxygenated product, potassium perchlorate, the equation expressing the change being usually written—

$$2KClO_3 = KClO_4 + 2KCl + O_2.$$

Lately the decomposition of the salt has been investigated by Teed, and also by P. Frankland and Dingwall, their results being communicated to the Chemical Society. Teed, from his results, derives the equation—

$$10KClO_3 = 6KClO_4 + 4KCl + 3O_2,$$

and in a second communication giving the results of experiments wherein the salt was more gently heated, he gives as a more approximate equation—

$$22KClO_3 = 14KClO_4 + 8KCl + 5O_2.$$

P. Frankland and Dingwall derive from their results the equation—

$$8KClO_3 = 2O_2 + 5KClO_4 + 3KCl.$$

The matter has also been discussed by Mills in the April number of the *Philosophical Magazine*. He there gives the following equation as expressing all known relations among those products:—

$$(1)\ 2nKClO_3 - (n-2)O_2 = (n+1)KClO_4 + (n-1)KCl.$$

Some years since I gave a general method for determining the coefficients in chemical equations (*Proc. Lit. and Phil. Soc.*, vol. xvii.). Suppose P molecules of $KClO_3$ to interact and give rise to Q_1 molecules of $KClO_4$, Q_2 molecules of KCl, and Q_3 molecules of O, then we shall have the equation—

$$(2)\ PKClO_3 + Q_1KClO_4 + Q_2KCl + Q_3O_2$$

equating the coefficients of K on each side—

$$P = Q_1 + Q_2,$$

the coefficients of Cl, when equated, give a similar equation. From the coefficients of O we derive the equation—

$$3P = 4Q_1 + 2O_2.$$

Hence we have four unknown quantities and only two equations Substituting in (2) we get—

$$(3)\ 2PKClO_3 = 2Q_1KClO_4 + 2(P - Q_1)KCl + (3P-4Q)O_2$$

an equation containing two variables with the condition that P and Q are integers and 3P not less than 4Q. From the equation it is manifest that from the interaction of a given number of molecules of $KClO_3$ we may have several solutions of the equation: the number of solutions may be found by finding the largest integer in $\frac{3P}{4}$; an additional solution may be found if we admit *o* as a possible value of Q_1.

P=11, the following equations are possible—

$$\begin{aligned}22KClO_3 &= 2KClO_4 + 20KCl + 29O_2\\ &= 4KClO_4 + 18KCl + 25O_2\\ &= 6KClO_4 + 16KCl + 21O_2\\ &= 8KClO_4 + 14KCl + 17O_2\\ &= 10KClO_4 + 12KCl + 13O_2\\ &= 12KClO_4 + 10KCl + 9O_2\\ &= 14KClO_4 + 8KCl + 5O_2\ (7)\\ &= 16KClO_4 + 6KCl + 1O_2\end{aligned}$$

Of these (7) is the equator given by Teed.

If in (1) we make $n=2$, the equation becomes—

$$4KClO_3 = 3KClO_4 + KCl;$$

if P=2 in equation (3) we have—

$$4KClO_3 = 4KCl + 6O_2,$$

and—

$$4KClO_3 = 2KClO_4 + 2KCl + 2O_2$$

Equation (3) may be converted into equation (1) by writing $\frac{P(n+1)}{2n}$ for Q, *n* being a new variable, and then multiplying both sides of the equation by $\frac{n}{P}$. If in (3) we P=1, we cannot derive the equation usually given without employing a fractional value ($\frac{1}{2}$) for Q. Can this imply that the equation is impossible, for can we have a fraction of a molecule? The arbitrary connections of P and Q may be shown as follows:—Collecting the terms involving P on one side and those involving Q on the other, we have—

$$P \times (2KClO_3 - 2KCl - 3O_2) = Q \times (2KClO_4 - 2KCl - 4O_2),$$

or—

$$P \times o = Y \times o.$$

Ordinary Meeting, November 1st, 1887.

Mr. John Angell, F.I.C., F.C.S., in the Chair.

Professor Schuster mentioned some experiments made by Prof. Hertz, of Carlsruhe, pointing to a curious effect of light in the electric discharge. It seems, according to these experiments, that when ultra-violet light is allowed to fall on spheres of metal between which electric sparks are produced, the sparks pass more easily, and can be obtained of greater length.

Dr. Hodgkinson mentioned an electrical property of quartz which he had observed, and which, if established, prove the unsuitability of this substance as a covering medium for compasses, watches, and other magnetisable instruments.

Ordinary Meeting, November 16th, 1887.

Professor Balfour Stewart, LL.D., F.R.S., President, in the Chair.

"*On the Electrical Attraction of Quartz, and the Unsuitability of this Substance as a Protecting Medium for Compasses, Watches, &c.* By Alex. Hodgkinson, M.B., B.Sc.

Quartz, like most other substances, becomes electrified by friction, and also possesses the property of remaining in an electrified condition for a period varying from ten minutes to half an hour after the friction has ceased. When this medium is used as a cover for compasses, this electrical property may manifest itself in such a marked manner as to render the readings of the instrument utterly unreliable, and more especially is this the case where the instrument is provided with a quartz cover back and front. In the compass exhibited the back and front of the instrument consist of two plano-convex lenses of quartz with their plane surfaces towards each other, the needle rotating between these covers on an axis, the extremities of which fit into two conical holes in the centre of the quartz covers. In the case of this instrument the mere act of removing it from the warm pocket is usually sufficient to cause the needle to assume a fixed position in relation to the compass itself, and quite unaffected by the magnetic attraction of the earth. If, whilst in this condition, the instrument is rotated, the needle also rotates as if a fixture. If the surface of the quartz be rubbed with the dry finger in a radial direction the needle at once takes up a position in the same direction, and if compelled by shaking to change its position it resumes it when allowed to remain at rest. When the compass is so turned that the axis of the needle is in the direction of the magnetic force of the earth, and the needle therefore in equilibrium, the effects of radial friction become still more marked. As might be expected, the property is not confined to quartz. A compass covered with glass exhibited the same phenomena, with the important difference that in this case the attractive influence ceased with cessation of the friction. That the attractive influence is quite independent of the magnetic force of the needle is proved by the fact that an instrument similar in every respect to the first-mentioned instrument, excepting that the needle was left unmagnetised, exhibited the same phenomena. The action is therefore one of simple electrical attraction.

CORRESPONDENCE.

ANALYSES OF MIXED PAINTS.

To the Editor of the Chemical News.

Sir,—In answer to your correspondent, R. S., the analysis of mixed paints will depend on whether he is dealing with "pigments ground in oil" or paints mixed "ready for use."

A weighed quantity of the pigment ground in oil is placed in a plugged filter tube, and is carefully washed with carbon disulphide until all traces of oil are removed.

The disulphide is evaporated when the weight of oil is obtained.

Mixed paints may be treated in the same way, using petroleum spirit instead of carbon disulphide, The oils, &c., thus extracted will consist of linseed oil, boiled oil, perhaps resinous matter, &c., turpentine, shale spirit, or petroleum: these two latter are largely used to replace turpentine.

To separate and estimate the oils, chloride of sulphur is added, when the oils will be precipitated, and the weight of turpentine, &c., may be obtained by difference. Resin, if present, may be extracted by alcohol from the matter removed by carbon disulphide; alcoholic solution of soda in some cases is necessary for this purpose.

The pigments are thus obtained in a dry state, free from oil, and may be examined in the usual way.

It is a common practice to burn off the oils, &c., but this is a mistake, as we ought to know something of the "body" giving material, as well as of the *et ceteras* used in rendering the paint "fit for use."—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove,
Forest Gate, E.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 22, November 28, 1887.

Action of Vanadic Acid upon Potassium Fluoride.—A. Ditte.—Vanadic acid, melted with potassium fluoride, forms compounds more or less rich in fluorine. The same compounds are produced in the presence or in the absence of air, though in the former case a certain quantity of potassium vanadate is also formed.

Ammoniacal Zinc Cyanides.—Raoul Varet.—Unlike the zinc chloride, bromide, and iodide, zinc cyanide yields, with ammonia, only two compounds according as water is present or absent.

Application of a Process of Senarmont's to the Production of Celestine and Anglesite in the Moist Way.—L. Bourgeois.—The process adopted was heating respectively strontium sulphate and lead sulphate in hydrochloric acid under pressure.

An Alkaloid extracted from the Fruit of Solanum grandiflora.—Sen. Domingos Freire.—The alkaloid in question—to which the author gives the name grandiflorine—is, like the fruit from which it is extracted, a powerful poison. The base gives the general reactions common to vegetable bases, but it has not yet been obtained in quantity sufficient for quantitative analysis.

Meteorites in Spectral Analysis.—M. Stanislas Meunier.—The author thinks that there is room to protest, in the name of Natural History properly so-called against the assimilation established in the recent memoir of Mr. Norman Lockyer, between meteorites and molecules which are amorphous, or at least whose physical and chemical properties may be considered independent of their structure. It must be remembered that meteorites are aggregations of different minerals, often very complicated, whose existence supposes the successive play of determinable actions. The meteorite of Pallas cannot have resulted from reactions in the way of fusion, and its nature supposes naturally the anterior existence of an extensive and bulky total, of which it formed a part. It comprises, with a very regular structure, minerals so unequally fusible that the application of heat must disorganise it, as it would destroy an animal or vegetable structure.

Revue Universelle des Mines et de la Metallurgie. Vol. xxi., No. 3, May and June, 1887.

Modification of the Bichromate Volumetric Process for the Determination of Iron in Ores.—H. Bya.—In most cases iron exists in ores in the ferric state. For applying the bichromate method it must be previously reduced to the ferrous state. Hitherto this has been exclusively effected by the nascent hydrogen evolved by the action of zinc upon the acid added to the solution of the ore. But if we take as reducing agent stannous chloride the action is, practically speaking, instantaneous. To eliminate from the solution the stannous chloride which is there present in slight excess, we add an excess of mercuric chloride; a portion of this is reduced, forming mercurous chloride, which is precipitated, whilst the stannous chloride is transformed into stannic chloride. The ferrous solution may then be directly titrated with potassium dichromate.

Iodide of Starch.—After working upon cholic acid and more particularly upon an iodised compound of this acid, which behaves in a manner analogous to the iodide of starch, F. Mylius re-investigated the latter compound, arriving at the very unexpected conclusion that pure iodine does not colour starch blue; to obtain this colouration the presence of hydriodic acid or of a soluble iodide is necessary. The blue products known as iodide of starch should be compounds of 4 mols. iodide of starch with 1 mol. of hydriodic acid or of a soluble iodide.

Determination of Potassium Permanganate and of Manganese Dioxide with Hydrogen Peroxide.—H. Bya.—Dr. Lunge has formerly shown that permanganate, like chloride of lime and potassium ferricyanide, may be determined by treatment with oxygenated water in excess, measuring the volume of oxygen evolved in the nitrometer. In this case the available oxygen of the permanganate will be exactly equal to half the oxygen set at liberty. The analysis of peroxide of manganese can be effected in a similar manner. The sample of manganese in fine powder is first shaken up in the exterior portion of the analysis bottle with dilute sulphuric acid to eliminate any carbonic anhydride present. An excess of hydrogen peroxide is then poured into the small interior tube, the bottle is connected to the nitrometer, the substances are mixed by inclining the apparatus, and shaken until the decomposition is complete. Weldon mud may also be determined in the same manner.

Archives Neerlandaises des Sciences Exactes et Naturelles. Vol. xxii., Part 1, 1887.

The Non-Chlorophyllic Colours of Leaves and their Signification for the Decomposition of Carbonic Acid under the Influence of Light.—Th. W. Engelmann.—The author discusses the question in what degree the different groups of rays of the spectrum participate in the decomposition of carbonic acid in the assimilating organs of plants. He takes up the indirect method, examining what groups may be wanting without a cessation of assimilation. A mixed light complementary of the special colour of the assimilant chromophyll is the most efficacious in decomposing carbonic acid. Hence, where the incident light is deprived of red rays, red forms prevail in the struggle for existence.

On Some Derivatives of Inosite and its Chemical Function.—M. Maquenne.—The derivatives here studied are the hexacetic and hexa-benzoic inosite, hexa-nitro-inosite, and tetra-benzoyl-tetra-oxyquinone. Inosite is an hexatomic alcohol, comparable in all points with mannite, save in the facility with which it passes into the benzinic series by the loss of hydrogen or hydroxyl. It must not be regarded as an aromatic body, but as a mannite with a closed hexagonal chain.—*Bull. de la Soc. Chim. de Paris.*

MISCELLANEOUS.

City and Guilds of London Institute.—A Course of ten Lectures on the Chemistry of Oils and Fats will be delivered at the Central Institution, by Dr. A. K. Miller, Demonstrator and Assistant in the Chemical Research Laboratory, on Mondays at 4 p.m., during the Spring term, commencing on January 23rd, 1888. SYLLABUS: *Oils of Mineral Origin.*—Petroleum: occurrence, production, and treatment; purification, properties and uses of the various products, their composition, chemical and physical properties, and their examination for commercial purposes. Theories relating to the origin of petroleum. Shale oil. Paraffin. Manufacture of oil-gas. *Oils, Fats, &c., of Vegetable and Animal Origin.*—Volatile oils, including turpentine. Fixed oils and fats: occurrence, extraction, and estimation. Physical properties. Constitution, decomposition, and chemical reactions. The different series of so-called fatty acids. Soaps. Glycerine. The chemical examination of oils, fats, and waxes; their classification, and the discussion of the properties, uses, tests, &c., of the chief members of each class.

At the Finsbury Technical College a Course of about six Lectures on Photographic Chemistry will be delivered by Prof. R. Meldola, F.R.S., F.I.C., F.C.S., commencing on Wednesday, January 18th, and being continued on successive Wednesdays. The Lectures will commence at 7.30 p.m. The object of this course is to develop the scientific principles upon which modern photography is based, so as to enable professional and amateur photographers to keep abreast of recent advancements in the subject. Those who attend the Lectures will have the opportunity, if they desire it, of receiving practical laboratory instruction in the testing and valuation of photographic chemicals. SYLLABUS OF LECTURES.—The action of light upon elements and compounds. Photo-physical and photo-chemical changes. Combinations and decompositions effected by light. The photo-chemical reactions of the salts of iron, mercury, uranium, copper, gold, platinum, the chromates, &c. Specific action of light and of the spectral colours on the salts of silver. Effects of the compounds associated with silver salts. Different molecular states of the silver haloid compounds. Recent researches on the photochlorides.

On Certain Derivatives of Dinaphthyl.—Paul Julius.—The author describes the preparation of the dinaphthols α and β, the sulpho-conjugation of the latter of these compounds, the preparation of dinitro-β-dinaphthol disulphonic acid, and the azo-compounds of α-dinaphthol.—*Mon. Sci*

MEETINGS FOR THE WEEK.

MONDAY, Jan. 2nd.—Medical, 8.30.
TUESDAY, 3rd.—Pathological, 8.30. (Anniversary
—— Royal Institution, 3. "Astronomy: The Great Planets," by Sir Robert Stawell Ball, LL.D. F.R.S.
THURSDAY, 5th.—Royal Institution, 3. "Astronomy: The Comets by Sir Robert Stawell Ball, LL.D., F.R.S.
FRIDAY, 6th.—Geologists' Association, 8.
SATURDAY, 7th.—Royal Institution, 3. "Astronomy: The Stars,' by Sir Robert Stawell Ball, LL.D., F.R.S.

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